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THE WATER SUPPLY OF GREATER VANCOUVER[1]

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On the 6th day of April, 1886—a date within the personal recollection of many men of middle age—three events of importance occurred in the history and development of the area now generally spoken of as Greater Vancouver. On that day the Legislature of British Columbia incorporated the City of Vancouver, the Vancouver Water Works Company and the Coquitlam Water Works Company. The subsequent development and the future prospects of the enterprises then projected by the two Companies form the major part of the subject of this paper.

The Indian bands whose fishing and hunting grounds lay in this region had in still earlier days realized the gradual encroachment of the white man, for the Cariboo gold rush of 1858 had accustomed them to the restless energy of the prospector, the miner and the trader.

In 1859 the site of the City of New Westminster was selected for the future capital of the newly created Crown Colony of British Columbia, which was destined within the period of a few years to be united with the older Crown Colony of Vancouver Island and in 1871 to become a Province of the Dominion of Canada.

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The land locked harbour of Burrard Inlet was early chosen as the location of mills in which were sawn the timber from magnificent forests of Douglas fir and cedar with which nature had clothed the British Columbia coast. The "Hastings Mill Site" in what is now the centre of Vancouver's waterfront, was selected in 1865 as the location of a great lumber mill because of the availability within easy distance of a fresh water supply from Trout Lake, a small lake in what is now the mid-eastern part of the City.

White settlement induced by the lumbering industry began about the same time on the North Shore of the Harbour and the area eventually became organized into the Municipality of North Vancouver in 1891.

The selection of Port Moody, at the head of Burrard Inlet as the early terminus of the Canadian Pacific Railway whose first transcontinental train reached that place on November 8, 1885, was later to be revoked in favor of the rising settlement 15 miles nearer the Ocean, to whose incorporation as the City of Vancouver on April 6th, 1886, we have already referred. Six weeks after incorporation the little place lay in ashes—the result of a forest fire. With renewed energy and vision the pioneers grappled with the complex problem of laying afresh the foundations of a City. It was an eventful day when on the 23rd of May, 1887, the first through passenger train from Montreal steamed into the new terminal station of the Canadian Pacific Railway.

A primary essential of the rising City was a water supply. Anticipating the final location of the railway terminus the problem had been brought to the attention of the late George A. Keefer, Mem. Can.Soc.C.E., a then distinguished engineer who instructed a young and active assistant, the late Henry B. Smith, M.Can.Soc.C.E. to make an investigation into the possible sources of water supply available to the City, with the result that the Capilano River was selected. A Company composed of business men of the Province had been incorporated and by June, 1887 the system was set out and contracts for its construction let. These were days of enterprise and citizens with visions of the future of the older City of New Westminster had selected one of its rising engineers, the late Arthur E. Hill, M.Can. Soc.C.E. to investigate and recommend a source of water supply that would meet not only the growing needs of that City but might be extended to the very Westerly boundaries of the new City of Vancouver. And so the Coquitlam Water Works Company was

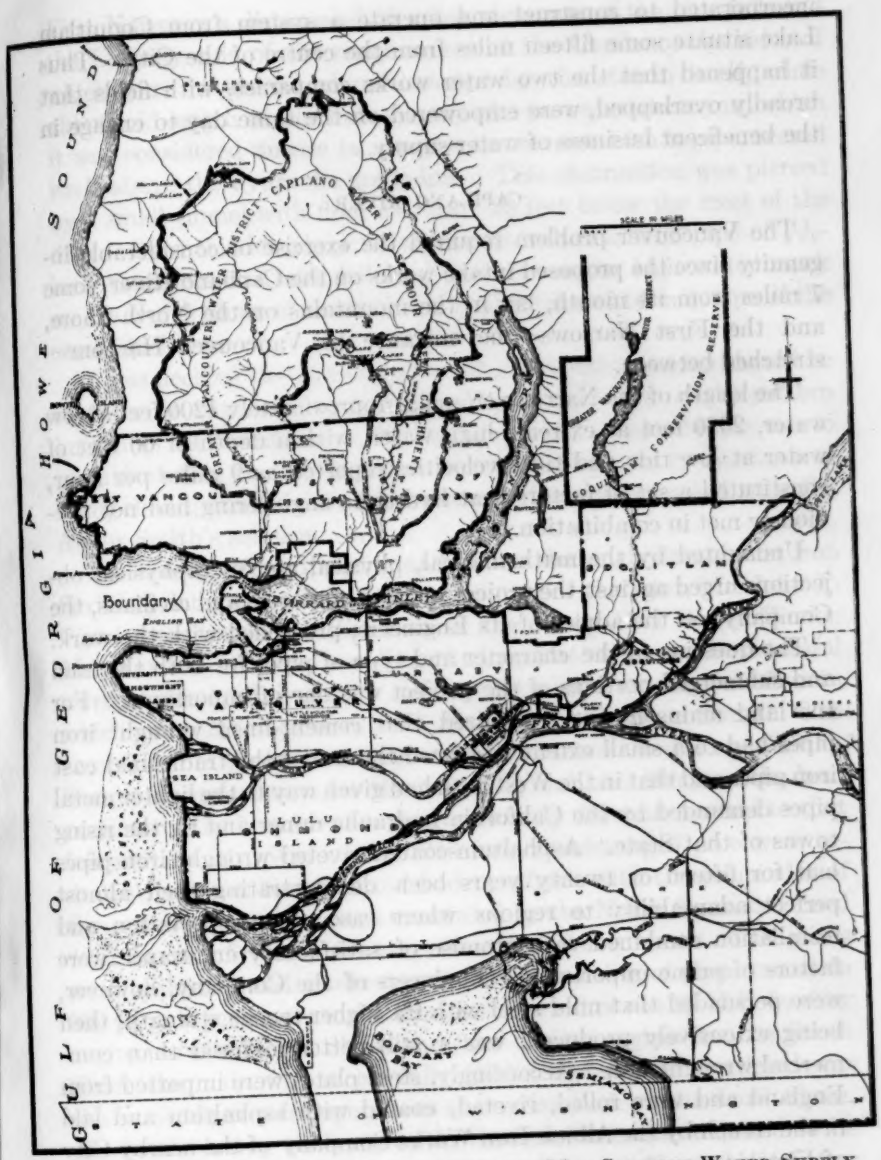

FIG. 1. GREATER VANCOUVER WATER DISTRICT—MAP SHOWING WATER SUPPLY SOURCES AND SYSTEMS

incorporated to construct and operate a system from Coquitlam Lake situate some fifteen miles from the centre of the City. Thus it happened that the two water works companies, with fields that broadly overlapped, were empowered on the same day to engage in the beneficent business of water supply.

CAPILANO RIVER

The Vancouver problem required the exercise of considerable ingenuity since the proposed intake works on the Capilano River, some 7 miles from its mouth, lay in the mountains on the North Shore, and the First Narrows—the entrance to Vancouver Harbour—stretched between.

The length of the Narrows crossing, approximately 1200 feet at low water, 2680 feet at extreme high water, with a depth of 60 feet of water at low tide and tidal velocities reported as 9 miles per hour, constituted a set of factors that hydraulic engineering had not previously met in combination.

Undaunted by the mathematical, physical and metaphysical objections urged against the project by both engineers and civilians, the Company, on the advice of its Engineers, proceeded with the work.

The question of the character and type of pipes for both the land and submerged portions of the project was one of importance. For the land mains it was recognized that cement-lined wrought iron pipes had to a small extent displaced the use of the traditional cast iron pipes and that in the West both had given way to the lighter metal pipes demanded by the California hydraulic miner and by the rising towns of that State. Asphaltum-coated riveted wrought iron pipes had for fifteen or twenty years been demonstrating their almost perfect adaptability to regions where ease of transportation and installation combined with promise of satisfactory endurance were factors of prime importance. Engineers of the Company, however, were persuaded that mild steel with its higher tensile strength, then being extensively produced, was a still better material than commercial wrought iron. Accordingly, steel plates were imported from England and were rolled, riveted, coated with asphaltum and laid in the trench by the Albion Iron Works Company of the nearby City of Victoria.

A wooden rock-filled crib intake dam 384 feet in length, with its crest at elevation 417 feet above high water mark of Burrard Inlet, was built under conditions of great difficulty. From the intake to the

First Narrows, a distance of 6½ miles, the route of the pipe followed the Easterly side of the rough valley of the Capilano, the sides of which were in several places invaded by the stream itself, while about mid-length of the route the top of a post-glacial canyon, which it was considered unwise to attempt to traverse with a pipe, reared itself above the hydraulic grade line. This obstruction was pierced by a small tunnel with floor elevation 28 feet below the crest of the dam. Over this length of 2.6 miles a 22-inch diameter pipe of $\frac{11}{100}$-inch thickness was laid, followed downstream to high water mark on the North Shore of the Narrows by 3.9 miles of 16-inch pipe of the same thickness.

It was decided that the pipes for the submerged crossing should be cast iron in two lines, each of 12 inches in diameter, of the pattern known as the Ward patent flexible joint pipe. Only one line was to be laid at this time. The pipes were manufactured in Scotland of hard, close grained, white cast iron and thoroughly coated with Dr. Angus Smith's solution.

The contract for supplying and laying the single line of cast iron flexible joint pipes was let to the patentee of the joint, Mr. John F. Ward, sometime Chief Engineer of the Jersey City Water Works. Mr. Ward had enjoyed a well merited reputation for much successful work of this kind, but after a determined but unsuccessful effort in which only 216 feet were laid, he abandoned the contract. The completion of the undertaking was let to Messrs. Keefer and McGillivray, the contractors for the trenching and backfilling on the land portions of the line, who adopted an entirely different method to that followed by Mr. Ward. The 216 feet of submerged pipe were redrawn from the Narrows and laid up afresh with the remainder of the cast iron pipe in a ditch excavated on the North Shore and lined with barked fir trees forming three parallel runners. The joints were all leaded and caulked and the whole string of pipes tested to 300 pounds per square inch, when with the aid of one 30 H.P. hauling engine on the North Shore and four similar engines on the South Shore the main was successfully hauled across. So restricted was the available area for operations at Stanley Park on the South Shore, due to the heavy timber growth, that all the tackle required to be overhauled for each 56 feet of pipe advance. Nevertheless after nine successive hours of labour the pipe successfully emerged on the South Shore. The 16-inch steel pipe was continued across Stanley Park and some 350 feet of shallow water at Coal Harbour crossed

with a 16-inch riveted steel main $\frac{3}{16}$ inch thick, fitted with cast iron flexible joints. The 16-inch main continued thence to the then centre of the City and in the morning of March 26th, 1889, Vancouver's first water supply reached the termination of its system at the street intersection just one block distant from this Convention Hall—almost exactly 10 miles from the Intake Dam. The capacity of the system was computed at $4\frac{1}{4}$ million Imperial gallons per day.

It is of interest to note that even at the date of completion of the contract so little was known of the geography and topography of the region that the Engineer put on record the statement with respect to the Capilano River that "prospectors who have penetrated its canyons, and claimed to have reached its source, estimate its length at no less than fifty miles." Its length is actually eighteen miles. It will be of further interest to record here the fact that except for about 1000 feet, all of the original 22-inch and 16-inch riveted steel pipes on the North Shore are still in service.

The additional submerged main was presently laid and in 1891 the City of Vancouver purchased from the Company its whole water system both supply and distribution, at an arbitrated value of $454,182.00. The young City grew rapidly and under the direction of Col. T. H. Tracy, City Engineer in 1893, an open earth-embanked concrete lined reservoir of 10 million gallons capacity was constructed in Stanley Park at an elevation of 240 feet above sea-level. Five years later an additional 22-inch main was built from Capilano tunnel to the City and the first flexible joint cast iron pipe of 18 inches diameter drawn across the Narrows.

The whole region was approaching a period of unprecedented growth. Improvements in all directions were necessary to keep pace with it. An actual increase of 330 percent in the population in the decade 1900 to 1910, in which the City richly shared, demanded among other things increased supplies of water. So it was that the old intake dam which had survived all the Capilano floods, but whose basin had filled with gravel was discarded for a new intake $\frac{3}{4}$ of a mile upstream, with settling basins at elevation 472 feet above sea level. The new direction of the water supply works had passed to Mr. H. M. Burwell, M.Can.Soc.C.E., who created the intake just described, and which is still in use, connected it with the old pipe head by a 36-inch continuous wood pipe and constructed a 30-inch wood pipe followed by a 30-inch steel pipe to a new tunnel at the Canyon and thence by a 26-inch steel main and two 18-inch sub-

merged mains across the Narrows. The Municipality of Point Grey had been growing lustily South and West of the City and joined in the latter enterprise involving the laying of a 26-inch pipe through the West end of the City and two lines of 18-inch submerged main 1500 feet in length across False Creek. Meantime the City had designed and completed in 1911, for the purpose of equalizing the fluctuation in the daily demand, an open concrete-lined reservoir of 25 million Imperial gallons capacity at elevation 397 feet on Little Mountain near the then Southerly boundary of the City.

SEYMOUR CREEK

The low water flow of Capilano River, originally estimated at 80 c.f.s. had been found to drop to less than half that quantity and as a consequence stream regulation by storage must be resorted to or an additional source of supply made available. Seymour Creek on the North Shore of Burrard Inlet approximately parallel to Capilano River and 5 to 7 miles away empties into the second constriction of the Harbour known as Second Narrows. In 1907 a road was built up the Creek, a boulder weir, intake works and small sediment tanks were constructed and $4\frac{1}{3}$ miles of continuous wood stave pipe 36 inches and 30 inches diameter, made from lumber sawn on the site of the work to a point on the stream where a steel bridge to carry both road and pipe had been built. At the bridge the pipe was of 32-inch riveted steel, followed by a further length of wood pipe to the Seymour Canyon. From that point to the Second Narrows 24-inch lap welded steel $\frac{5}{16}$ inch in thickness, manufactured in Scotland, was used.

The crossing of the Harbour at the Second Narrows is very similar to that of the Capilano pipe crossing at the First Narrows except that the depth of water is 72 feet at low tide. The total width is 2600 feet, but the low water crossing only 1000 feet. Two lines of 18-inch flexible joint cast iron pipes were laid up, leaded and caulked on the foreshore, similarly to the pipes at the First Narrows, and drawn across with certain refinements of operation dictated by experience. A 24-inch lap welded steel pipe connected the submerged mains with the City distribution, the total length of the installation being about $10\frac{1}{2}$ miles.

A further main was required by 1913 when a second intake was built about $\frac{2}{3}$ mile upstream from that just described and 7.1 miles of 36-inch riveted steel pipe varying from $\frac{1}{4}$ inch to $\frac{7}{16}$ inch in thick-

ness was laid to near the Second Narrows. There the pipe divided into two 24-inch pipes and each of them in turn into two 18-inch cast iron submerged pipes similar to those already described. From the South Shore of the Harbour a 32-inch followed by a 24-inch riveted steel pipe, was laid through the City streets to Little Mountain Reservoir, a total distance of 16 miles from the Intake. The 36-inch main was designed for an extension at a later date, to Seymour Falls some four miles further upstream.

SOUTH VANCOUVER

From the City's distribution system, supplied by the mains described, the Municipality of South Vancouver, which had by 1913 reached a population of some 30,000, received its water by arrangement with the City.

BURNABY

The Municipality of Burnaby, adjoining Vancouver on the East, had in 1911 by Agreement, arranged with the City of Vancouver for an enlargement of the City's proposed Seymour Creek main and for one of the 18-inch submerged mains at Second Narrows. From the latter the Municipality built a 24-inch steel main about $\frac{4}{5}$ of a mile in length to a pumping station at elevation 260 feet where two motor driven centrifugal pumps were installed to meet its requirements until the day when the 36-inch Seymour main should be extended to Seymour Falls and the pumps be no longer required.

NEW WESTMINSTER

The Coquitlam Water Works Company acquired the necessary lands for its dam and headworks and the right to certain lands for its pipe line, but did not construct any works. The Company sold to the City of New Westminster on March 18, 1889, its rights to construct water works for the supply of the City and the latter created a Commission for the purpose of carrying out the construction. The proposed plans had in October 1889, been submitted to no less an authority than the late J. F. Fanning, M.Am.Soc.C.E., who recommended a 16-inch main as a satisfactory means of supplying the needs of the population then estimated at 5000 and of taking care of a few years additional increase. Mr. Fanning thought it advisable that the supply main should be of steel and suggested that as the demands on the pipe increased a small reservoir should

be constructed in the City. He also designed the distribution system to be built of cast iron pipes. In 1890–1981 the City completed a 14-inch steel pipe line extending from a small dam at the mouth of the Lake to a small open reservoir of 900,000 gallons capacity, constructed at elevation 403 feet, in the City. The steel plates, sleeves and rivets for the 14-inch pipe were purchased in England by the City's Commissioners and supplied to the Contractor at ship's side in New Westminster. The steel varied in thickness from No. 12 to No. 9 Birmingham wire gauge. Pipes were built in 25-foot lengths, dipped in a hot coating solution of asphaltum and coal tar, and a sufficient number of lengths to satisfy the Engineer were tested to maximum pressures of 290 pounds per square inch. The contract for the fabrication of the pipe and for the trenching, laying and backfilling was let to the Risdon Iron and Locomotive Works of San Francisco who manufactured the pipe locally. The main had a capacity of approximately 600,000 Imperial gallons per day and supplied the City until 1912. Thirty years later a quantity of this pipe was removed from the old trench, cleaned, re-coated and placed in use for minor purposes.

In 1908 the needs of the City and suburban districts required that further supplies of water be made available. An open reservoir at elevation 255 feet above sea level, having a capacity of 2.5 million gallons was built in Queen's Park in the City, on the advice of J. F. LeBaron, M.Am.Soc.C.E.

The following year, by agreement between the City and the Municipality of Richmond the City undertook to construct a 24-inch steel main from Coquitlam Lake to Queen's Park Reservoir and to lay a 13-inch steel main from the Reservoir to the North Arm of the Fraser River, a submerged pipe across the River, and thence a 12-inch steel main to the Municipal boundary line of Richmond. The pipe was designed by and constructed under the supervision of Mr. J. W. B. Blackman, M.Can.Soc.C.E. then City Engineer of New Westminster.

As constructed the main is of riveted steel of $\frac{1}{4}$- and $\frac{3}{16}$-inch thickness, 25 inches in diameter, 14.1 miles in length, extending from the valve chamber immediately below Coquitlam Dam to the City, and was completed in January, 1912. The pipe was fabricated at a plant in the City. The lengths were 22 feet and 30 feet and the joints were made by riveting on a patent bell that required about 50 pounds of lead per joint. The pipe was designed and contracted

for in advance of the settlement of the question of a proposed new dam at the Lake to which reference is made below. The design therefore did not include recognition of the increased surface elevation of the lake as finally decided on, nor was the pipe in any event expected to be subjected to full static head. To this main, connections were made for the supply of water to the City of Port Coquitlam, the large Government Institutions at Essondale and to the Municipalities of Coquitlam and Fraser Mills.

From Queen's Park Reservoir a 13-inch lap welded steel main was laid to the North Arm of Fraser River. The submerged pipe across the River was also 13 inches in diameter, of lap welded steel $\frac{1}{4}$ inch thick with patent flexible muff joints in lengths of 12 feet and 16 feet, laid in a trench dredged in the River silt adjacent to the Lulu Island Bridge. Although the joints were regarded as permitting a deflection of 14° the design proved to be unsuitable and after an immediate failure had been repaired many leaks developed and the pipe was in a few months withdrawn. A portion of the pipe was re-laid on piles below River bed level under the opening of the swing span of the bridge and a wire wound wood pipe across the bridge connected with it, through which service was maintained until 1926 when a cast iron submerged main similar to those in use in Vancouver was laid. The remainder of the pipe to the Richmond boundary was 12 inches in diameter, a distance from Queen's Park Reservoir of 3.4 miles. A 24-inch branch main in the City was built in 1922–23 under the direction of Mr. H. Stewardson, City Engineer and a 4.2 million gallon open reservoir constructed beside the original high level reservoir, at the same time enlarging the capacity of the latter to 1.4 million gallons. Later a pump was installed in this branch main and operated to send water alternatively to the high level and Queen's Park Reservoirs and thus increase the carrying capacity of the whole Coquitlam system.

WATER RIGHTS

It may be desirable for the sake of clearness to refer at this point to the manner in which rights to the use of water within the Province are obtained. Under Provincial legislation the right to the use of all water in any river, lake or stream, not being a navigable river or otherwise under the exclusive jurisdiction of the Parliament of Canada is vested in the Crown in the right of the Province. The exclusive use of water for any purpose is acquired by license under the provision of the laws of the Province.

It so happened that Coquitlam Lake lay within what is known as the Railway Belt of British Columbia, an extensive strip of territory forty miles wide, extending from the Easterly boundary of the Province to the North Arm of Burrard Inlet, administered by the Dominion of Canada and concerning which there was for many years doubt as to whether the jurisdiction over the water was in the Dominion or in the Province. This question was settled by decision of the Imperial Privy Council in favour of the Dominion in 1910. By concurrent legislation of the Dominion and the Province in 1913 the administration of all water in the Railway Belt was transferred to the Province.

The Coquitlam Water Works Company, as we have seen, acquired certain rights from the Province. The Vancouver Power Company —a subsidiary of the British Columbia Electric Railway Company— subsequently acquired from both the Province and the Dominion rights to construct a dam at the outlet of Coquitlam Lake and to divert part of the waters of the Lake through a tunnel Westward for use in the production of power at sea level on the North Arm of Burrard Inlet. Later the Power Company desired to increase by 60 feet the height of the dam at the outlet of Coquitlam Lake authorized under its water rights and extended negotiations between the Company and the City ensued. The necessary agreements were finally concluded and the Power Company began in 1911 and completed in 1913 a large dam of the hydraulic fill type at this place. The maximum height of the dam is 100 feet, its extreme width at the base 655 feet, and its length including spillway 1200 feet. The spillway length is 250 feet with a freeboard of 15 feet; its elevation is 503 feet above sea level. This construction rendered useless the original intake of the City of New Westminster and entirely new intake works were provided. A substantial and handsome intake tower was erected about 1000 feet North of the dam from whence the water enters a tunnel about 2000 feet long, which passes under the spillway and sluice tunnel of the dam and terminates in a suitable chamber to which the new supply line to New Westminster is connected. These works were built under the direction of Mr. G. R. G. Conway, M.Can. Soc.C.E. then Chief Engineer of the British Columbia Electric Railway Company. The site of the dam had been reported on in 1909 by the late Mr. J. D. Schuyler, M.Am.Soc.C.E. and plans of the structure were prepared by him. The plans were later modified by Mr. John R. Freeman, M.Am.Soc.C.E., who was retained by the

Dominion Government to advise on the precautions to be taken to preserve the purity of the water supply of New Westminster and to report on the results of his inspections, during the progress of construction.

CITY OF NORTH VANCOUVER

In 1904 the Municipality of North Vancouver selected Lynn Creek, a smaller mountain stream lying between Capilano and Seymour Creeks, as the source of water supply for the growing community on the North Shore. In the following year the Municipality completed a wire wound wood stave pipe reducing from 14 to 10 inches diameter, 5 miles in length to the Harbour Front. A small diversion dam on the Creek served to divert the water to an intake tank supplied with screens at elevation 639 feet. In 1906 the most populous part of the Municipality was incorporated as the City of North Vancouver. The City in 1910 paralleled the former pipe for 3½ miles from the intake to the City boundary with a 16-inch pipe of similar kind. During 1912 and following years a small diversion structure was built higher up the Creek, at elevation 815 feet, and by means of a 16-inch wood stave pipe a portion of the Creek flow is diverted into a natural basin known as Rice Lake from whence an 18-inch pipe line more recently built from a tunnel outlet supplements the quantity of water available from the earlier intake works. The basin occupied by Rice Lake was cleaned of surface organic matter by hydraulic sluicing of the top soil into lower lands outside the Lake boundaries. Its holding capacity is about 40 M.G.

The water works of the City have for many years been under the direction of Mr. George S. Hanes, City Engineer.

MUNICIPALITIES OF NORTH AND WEST VANCOUVER

The former Municipality still receives some of its water supply from the City of North Vancouver and has small independent systems on Mosquito and Kilmer Creeks. From the former Creek it supplies a part of the higher lands of the City of North Vancouver. In addition the Municipality brings water through a 6-inch steel pipe to its higher lands from Kennedy Lake at elevation 3250 feet.

West Vancouver also has small independent water systems from Brothers, Cypress and Nelson Creeks from which water is drawn for the supply of adjacent areas.

PORT MOODY

The City of Port Moody is also independently supplied from Noon and Scott Creeks, two small streams on the North Shore of the Harbour, by a 10-inch wood pipe line about a mile in length built in 1916. Small impounding works were constructed on Cypress Lake in 1920–21.

GREATER VANCOUVER WATER DISTRICT

Some ten years or so ago the municipalities adjacent to the City of Vancouver under the spur of increasing population and inadequate water supply began a movement for the creation of some form of co-operative organization that would be empowered to provide a sufficient water supply for the necessities of the time and be sufficiently flexible to meet the varying needs of the future. The form of curve characteristic of the growth of Western communities does not in any sense approach a straight line; its variations are more pronounced than for older settled cities. When times are prosperous population increases rapidly and money is readily available for public works but when prosperity declines and growth ceases the demands for even so prime a necessity as adequate public water supply may remain unfulfilled. The prospect of this latter occurrence perhaps more than the actual presence of it in any accentuated form, along with a number of related considerations led at length to a concerted effort on the part of the City of Vancouver and the Municipalities of Point Grey and South Vancouver to create an organization for the purpose in question.

The Greater Vancouver Water District Act incorporating the District was passed by the Legislature of the Province in December, 1924. The District included the areas within the territorial limits of the City and the two Municipalities and provision was made for the subsequent addition of other municipalities from time to time.

The objects of the District are stated in the "Act" as "the acquiring, supplying, and distributing of water from any source or sources for the use of the inhabitants of the district for all purposes, or for the use of adjacent areas outside the district, including any unorganized territory, or for any other use or purpose within or without the district. It shall be within the corporate authority of the Corporation to extend its operations and to exercise its powers outside the limits of the district to any point or points within the Province where

it deems it expedient so to do in the interest and business of the Corporation."

The Act provided that the District should purchase from the City of Vancouver the water supply system of the City (but not the distribution system within the limits of the City) and that the price to be paid therefor should be the actual cost thereof to the City. The cost was to be determined by mutual agreement between the Councils of the Municipalities within the District. That part of the purchase price represented by the total amount of the outstanding obligations in the nature of bonded indebtedness created in respect of the property purchased and charged against the general credit of the City of Vancouver was to be paid by the District paying to the City the amounts of interest and the instalments of principal or sinking fund as the same accrue due, and the balance of the purchase price was to be paid in cash. The like conditions are to apply to the purchase of the supply systems of any of the Municipalities within the District. Provision was made for the taking of a vote of the electors of the Municipalities within the proposed district on the question as to whether they were in favour of the creation of the District. The latter provisions of the Act came into effect on the date of its passage. The remainder of the Act was to become effective on Proclamation of the Lieutenant-Governor after an agreement fixing the respective amounts and terms of the purchase price to be paid by the Corporation, had been confirmed by the several Municipal Councils, and after the vote had been taken and answered affirmatively as to each of the Municipalities.

A conference of the Engineers and Comptrollers of the proposed member Municipalities of the District was called to report on the extent of the portion of the waterworks system required for the operations of the District and to ascertain the purchase price in accordance with the provisions of the Act. The portion of the purchase price to be paid in cash and the portion to be paid by the assumption of the outstanding debentures under the terms of the Act were also to be determined.

As a result of the conference certain recommendations were made to the respective Councils, the votes of the ratepayers were taken as directed and in each instance the question was answered in the affirmative. Necessary amendments were made at the 1925 Session of the Legislature and the Act was brought into effect by Proclamation on January 19th, 1926. The organization of the District was im-

mediately effected and it began operations on February 3rd of that year.

The Act provides for the control of the District by an Administration Board to consist of three representatives to be appointed annually by the Council of the City of Vancouver and one representative to be appointed annually by the Council of each of the other Municipalities which are members of the District. On account of the preponderating interest of the City it is provided that the representation of the City on the Board shall be one more than the total number of all other representatives thereon.

Subject to the authority of the Board the undertakings of the Corporation are under the management of a Commission.

Briefly the Act empowers the District to:

(a) Purchase, construct and operate water works systems and to enter on lands and streets for that purpose.

(b) Acquire lands and timber within or without the District to be used for its water works or for protecting or preserving its sources of supply. Powers of expropriation are conferred.

(c) Incur debts, and to pledge the assets and credit of the District by borrowing monies by means of the issue and sale of debentures or other securities of the District, first having obtained the consent of the Lieutenant-Governor-in-Council.

(d) Add other Municipalities to the District upon such terms and conditions as may be mutually agreed upon.

The revenues of the District are raised by the sale of water. At the beginning of each year an estimate is made of the sum required for interest on borrowed monies, provision for sinking funds, for maintenance and operation and for necessary reserves, due allowance being made for monies receivable from the sale of water outside the District. The rate to be charged for water to each Municipality within the District is thereupon fixed by the Board on the recommendation of the Commission. If, however, it becomes apparent at any time during the year that the rates so fixed are higher or lower than are necessary to raise the required amount the Board shall revise and adjust the rates so that the total amount collected for the year shall as nearly as possible be equal to the amount required.

The rates are a special charge or lien upon each Municipality and the full taxing power thereof and all the property and assets of the Municipality within the District and are recoverable at the suit of the Corporation.

The debts of the District and the debenture obligations are a direct joint and several obligation of the District and of each and every Municipality within the District.

WATER SUPPLY AND STORAGE

At the date of organization the City of Vancouver had under construction a 36-inch riveted steel main from the second intake on Seymour Creek to the City. By arrangement with the City this work was continued under the direction of Charles Brakenridge, M.E.I.C., City Engineer, until July 1st, when the District took over the supply system. In the meantime surveys and investigations, under the superintendence of W. H. Powell, M.E.I.C., Engineer to the District, had been begun.

Among the things that demanded early attention was the creation of water storage to regulate the flow of both Capilano and Seymour

TABLE 1

Discharge of Capilano and Seymour Creeks for years 1912–1930 inclusive

GAUGING STATION	CATCHMENT AREA, SQ. MI.	AVERAGE DISCHARGE, C. F. S.	AVERAGE DISCHARGE PER SQ. MI., C. F. S.	MAXIMUM DISCHARGE, C. F. S.	MINIMUM DISCHARGE, C. F. S.
Capilano intake	67.6	740	10.9	16,900	28
Seymour intake	59.3	632	10.6	23,000	28

Creeks. These streams have similar run-off characteristics, as will be seen from table 1.

The pipe capacity of the supply system on July 1, 1926, was estimated at 39.7 million Imperial gallons per day (12.7 m.g.d. from Capilano and 27 m.g.d. from Seymour), but the low flows of the two creeks provided less than 31 m.g.d. all of which could not reasonably be made to enter the system.

Fortunately for the District three Lakes occupied basins in the mountains at the sources of the main creeks or their branches. The catchment areas of these lakes were not definitely known but preliminary surveys by the Provincial Water Rights Branch had gathered much preliminary information concerning them and the City had in 1920 under its then City Engineer, F. L. Fellowes, built a small wooden dam at the outlet of one—Burwell Lake—and had planned to drive a tunnel into it.

In table 2 will be found general data relative to the Lakes.

The catchment areas are small, but on account of altitude and climatic conditions are very productive. Precipitation records kept by the City of Vancouver at Burwell Lake for the years 1920 to 1925 showed an average annual precipitation of 180 inches—a minimum of 140 inches and a maximum of 271 inches. The lakes are bowl-shaped depressions in small hanging valleys over the rims of which ran the streams draining them into the respective main valleys. Immediately on the formation of the District plans were prepared for the construction of tunnels through the rock rims. Consideration was given to the question of taking in construction supplies by airplane, but the height of the mountains surrounding each

TABLE 2

Storage lakes—Greater Vancouver water district

LAKE	TRIBUTARY TO	ELEVATION ABOVE SEA LEVEL, FEET	AREA, ACRES	DEPTH OF LAKE, FEET	TUNNEL DEPTH BELOW LAKE SURFACE, FEET	LENGTH OF TUNNEL, FEET	STORAGE CAPACITY ABOVE TUNNEL, ACRE-FEET	CATCHMENT AREA, ACRES
Burwell	Seymour Creek	2,720	105	250	128	650	11,000*	917
Loch Lomond	Seymour Creek	3,421	105	170	116	1,140	5,600	690
Palisade	Capilano River	2,898	126	340	125	600	15,000	573

* Burwell Lake capacity may be increased to 14,000 acre-feet by construction of a small dam and the diversion of the discharge from two small lakes adjacent to it.

of the lakes made this method of approach impracticable. Trails for pack horses were located before the snow had gone and when built were travelled with much difficulty owing to the frequent rains so that detours often became necessary. The tunnels were all driven without unfortunate incident and the lakes allowed to drain. Water from Burwell Lake was available on August 17, 1926. The tunnels were small, about 5 feet by 7 feet in section. Near the outlet end of each a parallel tunnel 70 feet or more in length was driven at a distance of 50 feet to 70 feet from the main tunnel and connected to the latter by a cross-cut. These auxiliary tunnels were about 2 feet lower than the main tunnel. When the lakes had drained nearly to tunnel level permanent reinforced concrete bulkheads with

controls valves, were built in the main tunnels just outside the cross-cuts, the latter being used for drainage. When the main tunnel bulkheads were fully completed the flow was diverted through the valves and permanent bulkheads were later built in the auxiliary tunnels.

The limitations of load imposed by the precipitous trails necessitated the use of small valves for the outlets—each main bulkhead being provided with three 12-inch valves. Subsequently as the trails improved 18-inch valves were transported and installed in the auxiliary bulkheads. Steel pipes conduct the water from the valves to the tunnel outlets where it finds its way by the original overflow creeks to the main valleys. The lake shores below the original surface levels were found to carry unexpectedly large quantities of submerged timber. The rise of the lakes to permit storage of water for regulation of the main creeks in the late summer left little time before the autumn rains began in which to collect, pile and burn the timber. Portions of four years were thus occupied before the lake sides to elevations below the tunnel levels were made completely clean.

SEYMOUR FALLS

The presence of the Seymour Creek mains along the banks of the Creek for considerable distances where rock-filled timber cribs preserve them from the ravages of freshets suggested the desirability of locating new mains where the hazards were fewer and the maintenance costs would be less. It was considered desirable that in the location of the pipe extensions from the lower intakes to Seymour Falls the plan proposed in earlier years to extend along the creek banks be abandoned. Drilling operations at the site of the Falls during the summer of 1926 showed that the solid granite visible in the creek bed fell away on its Westerly side into what is evidently a deeply buried pre-glacial stream bed much below the present channel. The site was found unsuitable for a dam of sufficient height to create a large storage basin. As in most glaciated valleys the surface topography was found to reveal little evidence of sub-surface conditions.

The crest elevation of 640 feet above sea level selected for the Falls dam was determined to be the highest elevation at which water could be retained in the basin, and also provided sufficient elevation to permit the pipe lines from it to be built entirely clear of the valley bottom.

The pipe line extension to the Falls was located from a point above the existing Intakes on the Creek where connection could readily be made to the existing mains. The immediate construction of a 60-inch continuous wood stave pipe was decided on. Before the end of its useful life the catchment areas tributary to the several parts of the watershed would be known, records of actual run-off be available to permit more dependable estimates of regulated stream flow, the limits of the District be settled and the area determined to which this high-level water should be supplied. A location was accordingly made with great care for an eventual reinforced concrete conduit. Along this route, located so that it would not interfere with present or future constructions, the road was built and the line of the 60-inch wood pipe was so adjusted that its uninterrupted use would not conflict with the more permanent work later. The clearing through this heavily forested area was made 200 feet wide to reduce the danger from forest fire. Additional tall timber that might reach the pipe on falling was cut to afford protection.

The clearing of 180 acres of densely timbered land above the Falls and the construction of a reinforced concrete gravity overflow type dam with a 430-foot spillway creates a basin in which the storage water discharged from the upper lakes may be efficiently used to regulate the natural stream flow during the summer periods of minimum run-off.

The basin affords opportunity for the deposition of suspended matter during the heavy freshets that occur once or twice a year. A concrete-lined rock tunnel leads from the screen room in which is fixed a revolving screen, with space for an additional screen, to a gate house in which are mounted two 60-inch gate valves. The valve at the head of the existing wood pipe line is electrically operated. Electric current for the operation of the screen and valves, the lighting of the screen room, caretaker's house, and gate house is furnished by a small generator set driven by a water wheel supplied with water from a nearby creek.

SEYMOUR INTAKES

The original intake built in 1907 was abandoned in 1927 and the existing intake about 2000 feet upstream at elevation 483 feet was replaced by entirely new structures. The design was dictated by the limitations of the site and the necessity of maintaining the service from the old works during construction of the new. A creosoted

timber intake crib and flume, two concrete-lined settling basins 50 feet by 100 feet and 10 feet deep, and a concrete clear water basin behind the hydraulically operated screens furnish adequate facilities for the supply of water to a 30-inch continuous wood stave pipe of which 3 miles was built in 1927, replacing part of the earliest Seymour pipe. The arrangement at this intake is such that water from Seymour Falls through the 60-inch main which here connects by a wye with the two 36-inch steel pipes may, if necessary, be discharged into the settling basins for delivery under the lower head through the 30-inch pipe.

SECOND NARROWS

At the second Narrows four 18-inch cast iron flexible joint pipes connecting with the last 36-inch steel main were drawn across to the South side during 1926 and 1927. The number of 18-inch submerged mains at this point is now 10 of which 8 operate under a pressure of 275 pounds per square inch and 2 at slightly over 200 pounds.

The increase of head due to the construction of the works at Seymour Falls and the 60-inch pipe increased the carrying capacity of the two 36-inch pipes to an extent that allowed of the construction in the City of Vancouver in 1928–29 of an additional 36-inch main from the Second Narrows to Central Park and a 32-inch main Westward to Little Mountain Reservoir.

In 1928 the first unit, of 7 million gallons capacity, of a covered reinforced concrete reservoir with 22 feet depth of water was built at Vancouver Heights in the North-easterly part of the City, where tennis and lawn bowling clubs enjoy the facilities provided by the flat reservoir roof. The top water level is 342 feet and the ultimate capacity 48 million Imperial gallons. The reservoir is on the low head main and balances the daily fluctuations of draft in the Easterly part of the City.

The capacity of the Seymour system has by the works described been increased to upwards of 50 million gallons daily.

CAPILANO

Except for the replacement of the first $\frac{3}{4}$ mile of the 36-inch and 30-inch wood stave pipes on Capilano by a 60-inch steel pipe, the alteration and rehabilitation of part of the intake works, and the storage works at Palisade Lake, little construction has been done by the District on that system.

The age and condition of the system, which has a present capacity of 12 to 13 m.g.d. is such that plans are in hand for early replacements and additions.

WATER CONSUMPTION

The changing area of the District due to the inclusion from time to time of additional municipal areas does not permit of statistical data to illustrate average or periodic consumption of water in the whole District. Data for the two years 1929–1930, showing the quantities taken within the limits of the City of Vancouver and the Municipality of Burnaby are shown in table 3.

The use of water for sprinkling lawns, gardens and boulevards by a population fond of flowers and greenery, and in a region where their efforts are well rewarded, greatly increases the summer draft.

TABLE 3

Use of water in part of district south of Burrard Inlet, 1929–1930

YEAR	ESTIMATED POPULATION	AVERAGE DAILY THROUGHOUT YEAR, M.G.	AVERAGE DAILY USE PER CAPITA, IMPERIAL GALLONS			
			Year	Maximum, 3 months	Maximum, 4 weeks	Maximum week
1929	263,421	31.09	118	132	144	155
1930	266,129	31.80	122	147	163	173

A summer season of low precipitation adds heavily to the demand. The maximum use during an evening hour of a summer day, with no sprinkling restrictions, reaches a rate of 270 gallons per day per capita.

The character of the water delivered is well illustrated by a typical analysis from the Seymour mains. In general during freshets both Capilano and Seymour show similar characteristics of somewhat higher turbidity and greater bacterial count.

SURVEYS AND INVESTIGATIONS

The surveys and investigations, begun immediately on incorporation of the District, were directed to the determination of the resources of the watersheds, the location general character and types of structures that will be required to impound, divert and carry the water to the several parts of Greater Vancouver and the general sequence of construction from time to time for the most complete

regulation which the natural characteristics of the streams and the physical features of the terrain will permit.

Hydrometric observations have been carried on by the Dominion Water Power and Reclamation Service since 1912, constituting the

TABLE 4

Report of water analysis

Sample No. 970. Taken from Ingleton Street Meter House, February 23, 1931. Seymour water.

Chemical, p.p.m.

Color	5°	Ammonia, free	0.011
Reaction	Neutral	Ammonia, albuminoid	0.019
Turbidity	6°	Chlorine	2.61
Total solids	36.30	Nitrates	0.60
Volatile	11.63	Nitrites	None
Fixed	24.67	Hardness total	

Bacteriological

COUNT		FECAL BACTERIA		
37°C.	20°C.	In 0.1 cc.	In 1 cc.	In 10 cc.
12	56	0	0	0

TABLE 5

The average and minimum annual yields from the catchment areas above the present Capilano and Seymour Intakes for the water years (October 1–September 30), 1913–1929

CREEK	CATCHMENT AREAS ABOVE INTAKES, SQ. MI.	AVERAGE YIELD, C. F. S.	AVERAGE C. F. S PER SQ. MI.	MINIMUM ANNUAL YIELD, C. F. S.	MINIMUM C. F. S. PER SQ. MI.	CATCHMENT AREAS ABOVE FUTURE DAM SITES, SQ. MI.
Capilano	67.6	616	10.4	556	8.2	76.4
Seymour	59.3	729	10.8	404	6.8	68.3
Seymour above Falls	46.8					

first and only systematic records of stream flow. This service has been extended and a number of additional gauging stations established.

Table 5 exhibits a summary of the results of the run-off records,

together with the areas of the watersheds. Through coöperation with the Surveys Branch of the Provincial Department of Lands a photo-topographical survey of the watersheds and adjacent territory was made in 1926, the region mapped, and the catchment areas tributary to the several intakes and other sites obtained.

Many detailed surveys and studies were directed toward the location of possible dam sites and for suitable methods and sites for the crossing of the First and Second Narrows. Investigations of subsurface conditions by borings were carried to the point where the particular site under investigation was judged unsuitable or alternatively to an extent sufficient to permit the determination of the appropriate type or types of structure required at that site for the purpose.

These investigations led to the choice of the Second Canyon on Capilano and the head of Seymour Canyon as the sites of the future

TABLE 6

Future impounding reservoirs

IMPOUNDING RESERVOIR	ELEVATION, FEET	LENGTH, MILES	SURFACE AREA, ACRES	ACTUAL STORAGE (UPPER 100 FEET), ACRE-FEET	BILLIONS OF GALLONS	
					Imperial	U. S.
Capilano	471.5	3½	648	47,100	12.8	15.0
Seymour	475.0	4	853	55,500	15.1	17.6

storage and diversion dams. In each instance the top water level of the future reservoirs will reach and submerge the present intakes.

With the development of these reservoirs and the added storage capacity of the mountain lakes already developed, mass diagrams show that in the poorest water year during the period of record 1912 to date, the Capilano could have been regulated to 200 m.g.d. and Seymour to 220 m.g.d. From the latter approximately 80 m.g.d. will ultimately be taken at the Falls and the balance at the Canyon.

It is estimated that the Capilano dam will require to be constructed by 1940 and the Seymour dam perhaps 25 or 30 years later. In the interval, the additional hydrometric data and the operation of the mountain lakes will extend the records sufficiently to form a close estimate of the safe water yield of each watershed.

The Capilano dam will be within 3 miles and that at the Seymour only 2 miles from the North Shore of the Harbour, and the future

watershed areas will be increased as shown in the last column of table 5 over those from which the present supplies are drawn.

WATERSHED CONTROL

In 1926, the Provincial Government generously leased to the District for waterworks purposes for a period of 999 years at an annual rental of one dollar, all the Crown lands and timber in the two watersheds. This includes the major part of the virgin timbered areas of the upper watersheds. The District has since its formation purchased upwards of 13,000 acres of subdivided and unsubdivided lands from private owners, so that it now controls 93 percent of the entire area above the future dam sites and will, before the time arrives for the construction of the dams, have acquired the total area.

By Act of the Legislature the watershed area is reserved from location and acquisition under the Statutes governing mining operations in the Province.

Logging operations in the Capilano watershed have been carried on since 1918. The stand of merchantable timber now under control of the operators will under normal conditions require not more than five years for its removal. When logging operations have ceased this watershed will, like the Seymour, be uninhabited. The operations are under stringent sanitary regulations of the Provincial Board of Health and are under constant and continuous inspection. All employees must, before entering the watershed, first submit themselves to a blood test (Widal) and produce Certificates of Health stating that:

(1) The blood test is negative.

(2) He is not suffering from any communicable disease.

(3) He is not a "carrier" of typhoid fever, diphtheria or scarlet fever.

The location of camps is subject to approval of the Board and the regulations cover the sanitary precautions to be observed. The regulations of the District forbid access to the watershed except by permit and then only to those who have business therein and who comply with the Health Regulations.

The Alpine and Mountaineer's Clubs are each permitted to make not more than two climbing expeditions yearly, all members taking part complying with all the regulations and the climbing party being accompanied by a representative of the District.

AREA OF DISTRICT

The area of the District has been steadily increasing. The Municipality of Burnaby joined the District in 1927; North Vancouver in 1928; West Vancouver in 1929 and New Westminster, Coquitlam, Richmond and Port Coquitlam on January 1, 1931.

The addition of the water supply system of New Westminster from Coquitlam Lake, and its rights in the waters of that Lake,

TABLE 7

Municipal areas embraced in Greater Vancouver water district

	AREA, SQ. MI.	ESTIMATED POPULATION	MILES OF DISTRIBUTION MAINS OVER 3 INCHES IN DIAMETER	NUMBER OF WATER SERVICES
City of Vancouver	43.7	240,000	626	54,340
Municipality of North Vancouver	60.0	5,000	40	1,701
Municipality of West Vancouver	32.0	8,300	34	1,563
Municipality of Burnaby	35.0	23,000	140	7,599
Municipality of Richmond	50.0	7,000	35	1,350
City of New Westminster	5.4	22,000	86	5,137
Municipality of Coquitlam	54.7	5,000	10	434
City of Port Coquitlam	9.7	1,800	4	320
Totals	290.5	312,000	975	72,444
The District also supplies water in bulk to:				
University Endowment Lands, including University of British Columbia	5.0	475	8.2	100
Municipality of Fraser Mills	0.61	800	3.0	137
The independent supplies are:				
City of North Vancouver	4.9	9,000	48	3,200
City of Port Moody	4.7	1,000	9	330

described earlier in this paper, provides the District with a third source of supply. The water of Coquitlam Lake is unsurpassed in quality. That it should remain so was the purpose of the Dominion Government in creating by Order-in-Council of March 4, 1910, a reserve of 55,670 acres of land around the Lake for the protection and preservation of the water supply. The area is heavily timbered and totally uninhabited. The outlines of the watershed

have not yet been determined by survey. That the catchment area is highly productive may be judged from the record of annual precipitation which averages 141 inches for the past 25 years.

As a result of the agreement under which New Westminster entered the District a main from the District's Seymour system is now under construction from Central Park to the high-level reservoirs in New Westminster. The main is 7 miles in length and consists of approximately 2 miles each of 36, 32, and 28-inches diameter and 1 mile of 20-inches diameter electrically welded steel pipe with riveted field joints. This main increases the facilities for delivery to the higher areas in Burnaby and New Westminster and provides an alternative water supply to New Westminster in case of shut-down for any reason on the Coquitlam main.

Table 7 presents data relative to the area, population and number of the water services in the District which now extends from the Fraser and Pitt Rivers to the range of mountains to the North.

The City of North Vancouver supplies water to certain portions of the Municipality of North Vancouver and the latter in turn supplies from sources of its own part of the services in the Municipality, as well as a portion of the City of North Vancouver.

PROPOSED IMMEDIATE CONSTRUCTION

Plans are now well advanced for beginning new works to replace the old system on Capilano. It is proposed to make certain additions to the intake works and to construct a new wood stave pipe from the point ¾ mile below the Intake at the end of the existing 60-inch steel main to the dam site at the Canyon whence one of three steel pipes will be built to the North Shore of the First Narrows. From this point the water will cross the Narrows in a pressure tunnel 3,100 feet in length. It is proposed that the tunnel will be constructed at approximately 400 feet below high tide level. The vertical shafts at either end will have a finished waterway diameter of 8 feet and the tunnel 7 feet 6 inches. A 66-inch reinforced concrete or 70-inch steel pipe will connect the valve chamber at the South Shaft head with the City's distribution mains at the end of Georgia Street. This will be the first of two pipes to ultimately carry the full regulated flow of Capilano across Stanley Park and for which capacity the tunnel is now designed. It is expected these additions will be completed for the summer of 1933, and will bring an additional 30 million gallons of water per day to the Westerly part of the District. From

the end of Georgia Street mains will in due time cross the City and terminate at a balancing reservoir on Little Mountain at Elevation 340 feet where additional area has been selected for this purpose.

WATER RATE

The total budget requirements of the District for the current year are estimated at $634,500.00. The rate—with small temporary exceptions for special reasons—for water delivered in bulk to the member Municipalities for the year 1931 is set at 4.5 cents per 1000 Imperial gallons (= 3.75 cents per 1000 U. S. gallons).

Upon the restoration of normal times, with renewed growth of population, the heavier financial burdens due to the substitution for the older facilities of new and larger works and to the provisions made to safeguard the future, will be spread over large consumption and the District's rate for water, will undergo substantial reductions.

The fixed capital obligations of the District after purchase of the Vancouver systems in 1926 were $3,584,000. They have now reached nearly $7,000,000.

The District's water resources are such that an ample gravity water supply in a state of natural purity may be made available from its present sources for a population in excess of 3,000,000 and at a total net cost estimated at less than $25,000,000.

WATER PURIFICATION OUTSIDE OF CALIFORNIA[1]

By R. F. Goudey[2]

During the summer of 1931 Mr. H. A. Van Norman, General Manager and Chief Engineer of the Department of Water and Power, Los Angeles, sent Dr. Carl Wilson, Director of Sanitation, and the writer east to inspect the most up-to-date water and sewage treatment works. We visited seven filtration plants, ten water softening plants and four water systems having special problems as manganese, corrosion and taste troubles.

CLEVELAND, OHIO

The most outstanding old style filtration plant visited was the Baldwin Filtration Plant at Cleveland. It has a capacity of 165 m.g.d., although the present use is half that amount. Lake Erie water, relatively clean, but at times dangerously polluted from Cleveland sewage in a rather direct method of sewage reclamation, is treated with alum, soda ash, ammonia and chlorine. It is a beautiful, well laid out plant and the experimental work covering coagulation and filter details which is carried on there equals in importance the very excellent work being done at the Chicago Filtration Experimental Station.

Filtration plants merely to remove color and turbidity from water are no longer in vogue. All new plants invariably provide for softening. In fact, a number of old filter plants have switched over to it. At the present time there are over 154 municipal water softening plants serving over 15,000,000 people. As soon as water consumers in California become as insistent and demanding as eastern consumers, water softening here will come into general practice, because only 8 states have waters with an average hardness greater than ours and in 26 states the average water supplies are softer.

[1] Presented before the California Section meeting, October 28, 1931.

[2] Sanitary Engineer, Department of Water and Power, Los Angeles, Calif.

BAY CITY, MICHIGAN

Bay City, Michigan, has adapted its 20 m.g.d. plant to water softening and has incorporated emergency use of both activated carbon and ammonia to be able to produce at all times a perfect drinking water. The plant actually operates at about one-fourth of its designed capacity. Hardness is reduced from 250 to 140 p.p.m.

ST. LOUIS, MISSOURI

St. Louis at the Howard Bend Plant had the largest filtration and water softening plant which we visited. Raw water is taken from the muddy Missouri River at the rate of 55 m.g.d. and even with 75 per cent overload which the plant is subjected to, a water of good quality is produced and the hardness is lowered from 190 to 100 p.p.m. The chemical cost of softening is given as 1.2 cents per 1000 gallons, which is offset theoretically by a calculated soap saving to the consumers amounting to $1.72 per 1000 gallons. Both Bay City and St. Louis attempt to remove only the bicarbonate hardness with lime, which is the easiest part of the total hardness to remove.

PIQUA, OHIO

In the past few years radical changes have been made in the designs of modern filtration and water softening plants due, more than anything else, to the discoveries made by a Los Angeles man, Mr. J. Montgomery, at Piqua, Ohio. It is he who gave origin to the excess lime method of softening and also to recarbonation to remove excess lime. In the excess lime process lime is added to give 40 to 50 p.p.m. causticity which sharply precipitates magnesium which otherwise forms intermediate carbonates difficult to remove. After sedimentation the water is recarbonated to a causticity of minus 5 p.p.m. which throws down the excess lime as calcium carbonate and converts the carbonate which remains in solution to the bicarbonate form. It prevents coating of sand in the filters, deposition of lime compounds in the distribution system and eliminates the "lime" taste to the softened water. Little wonder that other plants elsewhere take advantage of the excess lime process as developed at Piqua. In addition, the Piqua plant which treats 5 m.g.d. is neat and attractive in appearance and is economical to operate. By the excess lime process water can be softened to a residual of 20 p.p.m.

which is 50 percent better than can be obtained by the old lime-soda process. At Piqua for practical reasons, the water is softened from 225 to 52 p.p.m.

FREMONT, OHIO

The excess lime process has been adapted to plants of small capacity. For instance, the plant at Fremont, Ohio, complete in all respects, treats less than 1 m.g.d. with one of the worst raw waters in the country. The supply is derived from the Sandusky River carrying over 100 B. coli per cubic centimeter half of the time and a hardness of 330 p.p.m. The treated water meets the Treasury Department Standards, has an agreeable taste, and the hardness has been reduced to 88 p.p.m. Another advantage of the excess lime process demonstrated by this plant, is sterilization without the use of chlorine by the high causticity in the excess lime treatment, which for very heavily polluted waters is considered even safer than chlorination.

SAGINAW, MICHIGAN

Saginaw, Michigan, rightfully boasts of having the classiest excess lime filtration plant anywhere. Powdered activated carbon is used periodically to control taste. In addition to possessing extreme flexibility between all its units, and "roominess," it appears as if nothing in the water works catalog was forgotten. The draftsman and architect vied to materialize a super-filtration monument. Little wonder that the cost of the plant reached $120,000 per million gallons, which is ten times the cost of another excellent plant from the standpoint of functioning which was built for private operation. Ordinarily the cost of excess lime and filtration plants varies from $35,000 to $75,000 per million gallons. These costs are not at all comparable to California conditions which eliminate powerhouse expense, steam pumps, large pumping quarters, housing of filters, and over ornamentation.

The Saginaw Plant was designed for 25 m.g.d. but is treating actually half that amount. With the exception of the Howard Bend Plant at St. Louis all of the plants which we visited were operating at one-quarter to one-half of their designed capacity, showing that Chamber of Commerce optimism is rampant elsewhere than in California. The hardness is reduced from 320 to 100 p.p.m. at a total operating cost of 3.7 cents per 1000 gallons.

BLOOMINGTON, ILLINOIS

The new 5 m.g.d. excess lime filtration plant at Bloomington, Illinois, which employs both ammonia and activated carbon is not only a model plant, but represents a successful venture in a rather unusual undertaking.

The former supply was derived from a well having a hardness of 800 p.p.m. The city lacked finances to ferret out a better supply and a contract was entered into with a private company to furnish water with a guaranteed hardness of less than 125 p.p.m. This company then constructed a 7,000 acre foot reservoir on Money Creek 14 miles out from the city and erected a complete plant on the shores of the created lake. The hardness in the treated water is 90 p.p.m. and the total operation cost, including pumping to the treatment plant and to the city, is 5 cents per 1000 gallons. The cost of power in this instance is 1.5 cents per kilowatt hour which is nearly double the rate common in Southern California. The installation cost was $60,000 per million gallons. This plant was one of the first to recirculate used coagulant. The alum and limed sludge from the second clarifier is continuously returned to the second mixing tank. It is said that the primary sludge cannot be returned because the odors and tastes locked up in it impart tastes and odors to the water.

FINDLAY, OHIO

The plant at Findlay, Ohio, is the brainiest of all the purification plants visited. It surpasses other plants in such details as unloading and storing of chemicals, measurement of water and proportional chemical feeding, surface wash for the filters, provisions for recarbonation and flexibility. Instead of using soda ash to remove a relatively high non-carbonate hardness, a portion of the excess lime softened water is filtered through zeolite filters and both softened waters are mixed in whatever ratio is necessary to meet the limit set for total hardness.

WATER CONDITIONING PRIOR TO FILTRATION

A rather curious situation has arisen in the east regarding the designing of filtration works. Up until recently hydraulic and sanitary engineers have dominated the field. Today all the modern plants are really designed by chemists. While engineers were and

still are quibbling about minor details such as filtering rates, size of sand, depth of sand, and rates of backwash, chemists have been quietly improving water conditioning which, after all, does 95 percent of the work before the water reaches the filter plant. The important features in purification are chemical feeding, initial mixing, prolonged coagulation by mechanical mixing, and efficient sedimentation in mechanical clarifiers. Filters are necessary only in the final polishing of the water and the details of design once thought all important become more or less immaterial.

Up until recently and still in the majority of plants chemicals are made into solutions before being fed into the supply. A number of filter plants manufacture chemicals in the wet state for direct use. The objections to the solution feed control of administering chemicals are the large amounts of space and labor required and the inability to change rates of doses until new batches of chemicals or tanks in use have been finished. By far the preferred procedure is to feed dry chemicals with mechanical equipment, of which there are over four types in successful operation. Alum and soda ash are being fed at a number of plants with Gauntt and Omega feeders. Lime is best fed by types manufactured by Wallace and Tiernan Company and the French Oil Company. The latter markets the invention of Mr. Montgomery at Piqua. Fremont, small as it is and where the tendency of most engineers would be to shovel chemicals in without refined control, finds chemical control important enough to employ four dry chemical feed machines. In large plants automatic weighing machines record weight of material discharged into the chemical feeders.

Good initial mixing is obtained in three manners: use of the hydraulic jump as developed at Cleveland and adopted at Bay City, severe baffling to give violent agitation as at Saginaw and rapid mechanical stirring as at Bloomington. Mixing of the chemicals intimately with the water is far more important than is usually recognized.

Prolonged mixing is essential in order to speed up coagulation and render it more efficient. The old method of around end baffles as seen in the secondary mixing chamber at St. Louis has gone out of style. In its wake has emerged a general adoption of the circular mixing tanks with mechanical stirring as worked out by Professor Langelier at Berkeley. These tanks are usually made of steel, 20 to 30 feet in diameter and depth.

Efficient sedimentation is now being secured with mechanical clarifiers. Not one of the plants visited which had mechanical clarifiers used any other than the Dorr type. The first installations were made fearful of results and invariably additional settling capacity in plain tanks was provided. The latest plants now employ nothing but mechanical clarifiers.

The largest clarifiers inspected were the four 150 foot square tanks at St. Louis. The Cedar Rapids Plant, itself creditable for its architectural features, used such clarifiers.

One of the best examples of what a mechanical clarifier can do over an equivalent volume of plain settling capacity can be seen at South Pittsburg. The 85 foot diameter clarifier there removes far more material than can be removed by other means and in spite of being heavily overloaded removes 90 to 95 percent of the load. The raw water is turbid, heavily laden with sewage, and at times acid from mine wastes. Through heroic chemical control and efficient sedimentation acceptable water is produced.

In the excess lime plants and also where re-carbonation is employed, secondary sedimentation is essential. At a number of plants plain sedimentation is employed, such as South Pittsburgh, Marion and Saginaw. However, the latest plants install mechanical clarifiers for both primary and secondary clarification and make them interchangeable.

Even small plants are now using mechanical clarification to advantage. For instance, the 50 foot square clarifier at Piqua and the 40 foot clarifier at Fremont give excellent operation results.

The size of clarifiers instead of being based on settling rates are still determined on detention periods, varying from 1.5 to 4 hours. The settling rates actually being employed vary from 100 to 2200 gallons per square foot per day. Observations clearly indicate that the settling rate of 680 gallons per square foot per day as provided at Findlay, Fremont and Piqua give satisfactory and efficient operation.

FILTER DETAILS

Filter details once thought thoroughly standardized, are being revolutionized. Dr. Wilson, in laying out the new Wilmington filtration plant at Los Angeles, designed the filters based on ferric chloride as a coagulant and made radical departures in size and depth of sand, surface back wash, wash water troughs and drifting jet inlets. Many eastern engineers are now finding that many of these

benefits apply with equal force with alum. They are now already and openly justifying use of coarser sand and less depth of sand. The Findlay plant has a modified surface wash. None, however, yet utilize the drifting inlet idea or low wash water troughs. Filter design has been shaken from a state of lethargy and less of precedent is likely to be followed in the future.

A few typical filter layouts include: Bay City, where inspection pits to gallery below are staggered with the operating table; Cleveland Division Plant in which the same also applies, but with a portion of the filters being uncovered; Cleveland Baldwin Plant which is impressive with its patterned tile floor; St. Louis with its spaciousness and galleries on both ends of the filters; and South Pittsburgh with abbreviated tables and compactness of design.

MISCELLANEOUS

Recarbonation is practiced to remove excess lime, to prevent deposition of lime solids in the distribution system, accretions on sand grains in the filters, and elimination of lime tastes in the softened water.

Carbonation is usually applied to the clarified water after softening with or without the use of additional coagulant to aid in precipitating calcium carbonate. The water is then settled before being filtered. The carbon dioxide is produced by burning fuel in a small boiler. It is then cooled and compressed. It is finally bubbled through perforated pipe at the bottom of tanks, giving 30 minutes detection, but, in some cases, is applied at channels to and from clarifiers.

Considerable information was obtained on the use of ammonia as tried out in two hundred plants. Ammonia in some instances is useful in counteracting chlorinous, algae and medicinal tastes, in controlling aftergrowths, and in carrying residual chlorine to the consumer's tap. The numbers of successful installations about equal the failures. The ratio of chlorine to ammonia now used is about three or four parts of chlorine to one of ammonia. Bay City uses ammonia for swampy odors and resorts to carbon treatment for others. Ammonia gives an initial lag in sterilization which may cause a false sense of security in the safety of supplies employing short contact periods, but for longer periods the total disinfecting power is greater. Whether a water company has the right to serve antiseptic water to domestic and industrial users is probably subject to serious question.

Ammonia gas is very easy to apply to a water. It is extremely soluble. At Bay City a known weight of gas is bubbled into a barrel of water and the solution is fed at a predetermined rate into the supply. At other plants, such as Bloomington and Cleveland, the gas is metered by ammoniators similar to chlorinators. It has been used during emergencies in solid form such as ammonium sulphate and ammonium chloride.

Activated carbon is not continuously used at any eastern plant and more water has been filtered through activated carbon at the Los Angeles Experimental Station than elsewhere. Carbon is used in both powdered and granular form. The powdered carbon at Bloomington is measured from dry feed machines ahead of final mixing tanks to remove phenols and tastes which ammonia cannot control. The granular form is used in the form of a filtering medium for the same purposes and does away with having a black sludge to dispose of and all the dirt attendant upon using the powdered form. Carbon also removes lime tastes where recarbonation is not practiced.

It is only through the excess lime method of treatment and filtration with super-chlorination followed by dechlorination with activated carbon that good tasting water of unquestioned superiority can be continuously supplied.

Laboratory control of eastern plants is carried to high degree of efficiency. Even such a system as the Wanaque supply, which only chlorinates, maintains a complete chemical laboratory. The laboratory at the South Pittsburgh Plant and Hackensack are veritable hives of industrial chemical and sanitary chemical activity, reminding one of a control laboratory in a huge chemical plant. The St. Louis laboratory at Howard Bend appeared unusually complete. For instance, the chemical cabinet has stepped up shelves so the label on every bottle can be readily seen. The Piqua laboratory, simple only to the point of doing efficient work, is combined with necessary plant control devices. The Baldwin Plant at Cleveland has the premier laboratory, the office of which resembles the manager's office of a large corporation. Eastern water works laboratories have reason to make the western water works operator envious. The answer is clearly that in the east successful operation can only be had through chemical and biological control.

BILLING AND COLLECTION METHODS[1]

By Carl K. Chapin[2]

Credit business recently leaped into a place of first importance in the business world; the rapid change from cash to credit basis was most apparent following our economic slump of ten years ago. This fundamental change in business methods has been viewed with alarm by many utility managements, with special reference to their problems in collecting and billing. This change has seemed to bring with it a defensive warfare on the part of the public. What they are fighting against is any policy of "pressure" for prompt payment of bills, and hitting hard at the same time in this campaign, against any broad application of adequate "deposits in advance." Hence the concern of many utilities which feel that such proposals to relax in credits is opposed to proven standards in their business practice.

Even when these changes are not viewed as revolutionary and alarming, there is an increasing interest in what seems to be the universal experience of *greater and greater resistance to collections* for the services which we, as water utilities, have in general supplied in the full faith and credit of a consumer's signature. We assume we must find ways and means to prevent our total commercial unit costs from increasing, or we may expect to find ourselves accused of retreating behind an alibi, such as the Law of Diminishing Returns, given as the excuse for not successfully preventing a disproportionate increase in the cost of doing business as our business has grown.

I for one do not wish to be counted among those who surrender just because credit racketeers have found the utilities easy to hold up. We are assured the public, as a whole, has good credit ratings. We must believe this. There is only a small part of the great general public which is irresponsible in credit matters.

If we cannot adopt some of the more common measures of protection used in other lines of business, such as repossession, charging increased collection losses to advertising, etc., we can look for other

[1] Presented before the California Section meeting, October 30, 1930.

[2] Commercial Director, Department of Water and Power, Los Angeles, Calif.

direct measures which will give utilities just as good, and perhaps better, protection from these unscrupulous individuals, whom I have just taken the liberty of calling "racketeers." For more than a quarter of a century I have watched the public pay for utility services. I share with many of you the conviction that today the public pays its just bills with better grace than ever before. I believe there is less deliberate effort to "beat" a street car ride, or attempt to avoid the full payment of a water bill, than ever before. I am speaking of the public generally. But there are a few exceptions to this rule. Toward these few we must adopt corrective measures to insure that we economically collect our fair return on the services we render. If we are successful we will discourage the "racket." If we surrender, we will stimulate it to new and probably alarming proportions.

Having dared to divide our consuming public into two classes of individuals, I am prompted to admit, and urge the necessity of our following billing and collection methods, which will sift the one class from the other, and preserve and develop our efficiency and good will with the major class of good credit users. With this large volume of prompt pay business working smoothly and efficiently, we may expect our unit costs to trend toward minimum values. Then we may reserve for the other and fortunately much smaller class, just that amount of so-called red tape on credits and collections which circumstances and experience in a particular locality seems to justify. The cost for this extra care will then be kept within minimum bounds and bring results.

The public is being trained to expect quicker and better service in the normal supply of all its wants. How often we hear the expression, "I want it right—and I want it right now." One of the evident purposes of this association is to keep ever present and stimulated, the *desire to improve* in order that we may keep fully abreast of the times.

We are going to briefly turn our attention to just a few things that represent constant points of contact in a commercial way between the public as a consumer and the utility. We are not presuming to deal with these commercial questions from the viewpoint of describing some queer method in business, nor some great curiosity to impress us for the moment and then be forgotten—except on rare occasions—afterward, but we hope to center thought on widely applicable principles which may here and there stimulate someone to even greater efforts toward improvement and efficiency. It is

sure to be old and trite to some; it is not too much to hope it will present new angles to others. Our effort is to concentrate on those subjects where we are most apt to find friction due to slowness in handling the public, or where we seem most often accused of going about it in the wrong way. The effect of either being to bring on heated discussions, which are too often truly costly, quite distasteful, and usually unnecessary.

For want of some better reason let us classify these subjects in the order of an assumed priority due to number of daily occurrences, or their relative percentage of activity in each class.

REGULAR CONSUMER BILLING

What is prompt and efficient service in making out billings for water used by consumers on regular services? A check of a few utilities will show that seven to eight days is the usual elapsed time between reading of meters and mailing or delivery of bills. We are doing a credit business and the quicker we get the money that belongs to us the better off we are in many respects. This money is non-interest bearing, but it will take the place of interest bearing money if we get it in the bank. It is non-revenue raising, yet it will earn revenue if we had it to invest in the system and did so. I mean just this—if the amounts regularly outstanding can be reduced on the average by a speeding up of billing procedure alone, it follows that the two preceding statements are substantially true. This money is then available for other purposes.

The only assumptions necessary to make are that it is not done at prohibitive additional expense and that collection methods and the rate of payments made by consumers following receipt of bills should remain the same.

It is safe to make the statement that in all but a few instances it is possible for utilities to complete the reading and billing operation ready for bill mailing or delivery in from three to five days. It also follows that our interest in this question is almost universal because very few utilities are doing this well. If it can be done, and has manifold advantages, why not look into it and make the effort? The answer may be found in properly timing the operations; changing shift hours in certain work; rerouting change orders; or in the checking of readings for errors, constants and extensions; perhaps in the application of mechanical equipment to billing methods; or in the form of bookkeeping ledgers used; in fact there are so many operations

and methods used that herein lies the secret stimulus to try and evolve new combinations which will result in improvements to any regular billing method. All of this does not mean to imply that we must junk any modern method or devices. It means to infer, and stands on the assertion, that we are not doing the best we can with what we have. We should do this. Try your own problem in simple arithmetic and see *what it's worth* to have three days more cash receipts in the bank instead of the consumer having the credit.

Granting the usual value of money to be 7½ percent, either as an interest plus redemption charge, or as the net earning value, we arrive at a pretty strong argument for thinking this over before deciding to "let good enough alone."

TURN ON AND TURN OFF SERVICE

There are few things in our business that are more difficult to explain than the use of seemingly heavy equipment carrying several men when they appear at a consumer's to execute a regular turn on of service. It is not in the interest of economy of either time or money, nor does it foster good public opinion to be conducting our business in an inconsistent manner, yet I dare say that even among the utilities represented in this group such things, while contrary to the rule, do occur in altogether too many instances. This inconsistency, where it does exist, is more frequently occasioned by the failure of the commercial sections to assume their proper share of the business responsibility and make all regular, ordinary turn on and turn off calls with men working singly and equipped with light transportation. If this is the rule, then we might see the commercial sections properly passing on to the appropriate street departments those cases which, by office record, due to size or previous warning, had been reserved for the more expert and exacting attention of distribution men.

If on and off orders are handled by a dispatcher, using the telephone to give orders and receive readings and O. K.'s, each case to be later confirmed by a daily work sheet made out by the field men, we not only begin to please the public by better service, but we set in motion a more effective billing and collecting method.

This class of call properly belongs to a group of one-day service requirements in one business. Prompt or quick service is a relative term. We give it value usually by the association of ideas. We accept a few minutes as the proper time to wait for a long distance

telephone connection. At the same time we consider one-day air mail service between Northern and Southern California to be equally entitled to all that is inferred by the expression of prompt service, and neither of these developments was possible until a comparatively recent date. To a prospective consumer, rushing through all the details of moving his or her household, one-day service seems prompt in all probability. Now *most* of the utilities represented in this gathering do make turn on service a one-day rule, *many* of us do not make turn off service so promptly, and *very few* do make one-day service on closing bills.

CLOSING BILLS

If you do not make closing bills on a one-day schedule you have confusion as to responsibility for several days of service. You may have to cancel a regular bill after it has been made and delivered, in order to split it between two consumers; you probably have to prorate the bill if the off consumer wishes to pay at once or else stand a good chance of having your bill follow through the mails maybe never to be delivered and never to be paid.

If a consumer orders service off today you should be able to give or mail the closing bill within twenty-four hours in the great majority of cases. Impossible? Just try it out with an open mind and you will be surprised to find it not hard to do and you will see how much billing and collecting difficulty it eliminates. Then too, if you are prepared to regularly act so promptly in such cases, you will not have so many *Rush Orders* where bankruptcy, final notice and other special case orders are issued calling for unusual action. Also if the consumer has a deposit with you and you are able to settle both transactions in full the day following the making of the off order, you will have your money, and the consumer will have his or hers, and both will be pleased. Very few utilities pay much attention to this question of one-day service in closing bills. There is so much to be gained by it, that it is a mystery why so few follow some such procedure. On and off orders in any one month may easily amount to as many as 6 or 8 percent of the total number of accounts. Closing bills approximate but one-half of this number, or 3 to 5 percent.

The speed with which on and off business may be handled has a very important bearing on the cost of closing bill collections as well as the final amounts that will eventually be determined as uncollectible. This will be referred to in more detail a little later.

METHODS OF COLLECTION

The experience of utilities is not unlike that of the broader lines of general mercantile business in regard to the manner in which they receive payments for services rendered. They all depend upon three mediums. Mail, Cashiers, and Collectors. For that reason we are interested alike in reaching the cheapest and best combination of these principle methods of handling our receipts. And for the same reason, utilities must be quick to grasp any benefits which may accrue to them by following any good practices introduced by mercantile leaders in their training of the public to present-day business methods.

The most expensive method of collecting or receiving cash is across the doorstep of the consumer through the medium of a collector's personal call. Next in line of high cost is the payment of bills at cashiers' windows, usually in the most pretentious quarters and under the best surroundings the utility can afford. This latter is in sharp contrast to mercantile business where cashiers are relegated to some back or upper floor space in favor of prominent first floor display of sales goods. The third method, and least expensive one of all, is by mail, principally in the form of checks. Now the ratio of cost of these various methods is very wide. Startlingly so. It usually cost five to ten times as much to care for cashiers' window collections as it does to handle the same total amount through the mail. And it costs ten to twenty times as much to handle collections in the field as it does to use office cashiers. So the ratio between the poorest and the best is more than fifty to one and may reach two hundred to one. Isn't it rather strange then that we do not find our utilities making any great effort to encourage mail payments? Is it worth much consideration.

In order that payments by check may be fully taken advantage of it is of course essential that certain minor troubles or possible inconveniences should be carefully handled in order to prevent the loss of either money or public good will.

Many utilities and big business enterprises seem unconcerned with payments received for which no account can be readily found to receive credit, and therefore such payments are classed as unidentified receipts and so entered in a separate ledger account until the consumer complains and furnishes the clue to completely identify the original transaction. This has many apparent disadvantages. Such occurrences are primarily caused by utilities keeping service records by

number or street addresses. Here the name of the consumer is not found alphabetically, being of secondary importance in any simplified reading and billing procedure. We can hardly blame the public for not fully understanding our reasons for adopting certain methods for our convenience, which, on rare occasions, may cause the consumer trouble. Rather in such cases we must cheerfully accept full blame for the inconvenience caused to the consumer and promptly take all the trouble to correct any such troublesome transactions.

A canvas of progressive business houses and utilities will always show a few who say cheerfully, "we have no unidentified ledger accounts." Others seem mystified as to the methods of accomplishing such results. The answer seems to be in having a perfect method of analysing receipts through the mail, which will efficiently determine the accounts to be credited, even when proper identification does not accompany the remittance. Any complete method will usually find every payment properly credited before additional billings can be sent to consumers, which would show them for the first time, that a previous payment of theirs has not been credited properly to their account.

It is apparent that we are here opening the door to an identification system which can and should function in cases of intentional bad check transactions. This system, if good, will also locate delinquents who move frequently, leaving unpaid amounts; and will be of great value in dealing with the habitually poor pay group. This will be covered more fully later.

It is a common occurrence in cities of 15,000 population and over, for 1 to 1.5 percent of all check remittances to be lacking in proper identification, such as failure to use bill, bill stub or statements. This starts a search for clues, and the completeness of the preparation for cases largely determines the efficiency or cost of handling them. It may be of interest to mention a few sources from which to gather information.

a. Is there an address on the check?
b. Is there an address on the envelope?
c. Is there a mercantile or firm name printed on check?
d. Is a statement belonging to *some other firm* enclosed?
e. Is the name in the telephone directory? A call in such cases usually finds the consumer so embarrassed at their oversight they will forever remember to enclose bill or statement.
f. Is the name in special directories of professional or tradespeople?

g. Is the name similar to others which are found?
h. Will the bank, or post office in case of money order, identify the account and give last address?
i. If they have moved from last address an inquiry from a former neighbor or the post office may get new address.
j. In special cases as earch of political registration list of voters may help to reach them.
k. Search of listed bills of *same amounts* shown in unpaid ledgers may locate the sender by process of elimination.

These cover most of the ordinary clews, and they are in general placed in the order of their availability and therefore only the remaining few get down into the lower groups where it is a slower and more troublesome process.

The value of a complete method is in avoiding the creation of a disgruntled consumer who is forever convinced you are either unbusiness-like or crooked in handling his money. Again, it will assist in handling the identification of *returned checks.* This is where a former consumer cannot be found at the address given by bill or check reference on the original account. These cases occasionally occur by some accidental error which prevents the check from passing through the bank, but more frequently it is where liberties are intentionally taken by the check writer with the desire to gain time or perhaps avoid payment.

RETURNED CHECKS

In the ordinary run of business we may look for one-half the number of returned checks daily or monthly as there are original cases of mail remittances which are lacking in proper identification. This means from one-half to two-thirds of 1 percent of the total bills rendered.

It has become altogether too common for hard pressed business firms and individuals to take advantage of bank and clearing house practice and gain a week or two additional credit, hoping to have it appear as an oversight or accident on their part because something was lacking in regard to a check drawn by them. Banks do not like this kind of business any more than the utilities, as these irregularities cause them additional trouble and expense. They will usually coöperate in reducing this class of unfair or unbusiness-like practice to its minimum.

If you will adopt means to distinguish the purely unintentional

and occasional cases from the recurrent and intentional ones you can save money in time lost and make better collections by sometimes not crediting your receipts with a suspicious check until it has been assured of being made good by the bank upon which it is drawn.

When cases occur which are unintentional it is quicker, and many believe it is better, to contact the check maker by telephone and in all politeness call attention to the incident. Usually they are so embarrassed by their oversight or mistake they will volunteer to take any steps you suggest to correct it. If they do not appear as the general run of folks, but are insulted or indignant because you do not again try to bank the check, or if they offer to give you another check in place of the one *already bad* your better judgment will prompt you to take one of several steps which will protect fully, in the event such a case should turn out to be an intentional effort to commit fraud. Incidentally these intentional cases are noted for their reoccurrence until they discover you are just a little bit too well prepared for their attempts to gain advantage by such petty fraud. Of course once in a while you avoid real loss, if some crook not suspecting your awareness of irregularities, attempts to defraud you and you turn him over to the police authorities.

We have gradually simmered our discussion down to where we admit in the face of things that it looks like there were a few people in the world who are intentionally out to defraud the utilities—and any one else perhaps. This brings us to a brief discussion of poor pay consumers.

POOR PAY CONSUMERS

If you knew in advance the credit history of all new consumers as well as your own books will later reflect their credit experience with you, how easy it would be to protect your interests by deposits, guarantees or guarantors, or bonds in the necessary cases, and at the same time avoid asking such credit assurances from the kind of consumers that frankly, and, with some justice, quickly resent any request for such deposit, bond, etc. Universal deposits for all consumers are becoming less and less the common practice; even where the user is not the property owner, and where the law does not make the bill for water a lien upon the property.

To begin with, an analysis of any utility or mercantile bad debt ledger will probably show that two-thirds of the money which is *lost* occurs on but one-third of the bad accounts. The happy situation

here is that having determined who the one-third of the total bad accounts may be, you can use this information in future transactions of contracts, credit, returned checks, extensions of time for payments, etc. Your treatment of the rest of the consumers is therefore just that much better, with due assurance of safety and pleasant business relations.

Modern cities seem to be the collecting place for poor pay individuals and much money can be saved with little additional expense if the right effort is made. Only a small percent of our consumers fall into the class of intentional delinquents in money matters. Good consumers are entitled to protection from the losses occasioned by such delinquents, and from the stigma which attaches to any universally applied credit plan which is adequate to cope with the worst citizen. It would seem also that here we have some chance of educating these bad credit consumers by the abrupt method of not allowing them to get away with anything unfair in their business dealings with us. This enforced care of credit relations on their part might in many cases become a new habit, well though forcibly formed. Truly a practical demonstration of the belief that "we are our brother's keeper," even though tempered by the admission that "carefulness in money matters pays many dividends in business."

THE DROUGHT OF 1930 AND SURFACE WATER SUPPLIES IN ILLINOIS[1]

By Winfred D. Gerber[2]

It frequently requires a severe jolt to bring about a realization of the magnitude of the economic loss which may occur because of a combination of circumstances only part of which may be subject to human control.

The great flood in the Mississippi River a few years ago awoke the residents of that valley to the realization of the great loss which occurred because of the high water and brought about a demand for properly conceived plans for relief, in anticipation of another such occurrence.

During the preceding 15 months there has prevailed a dry period which has come to be spoken of as the 1930 Drought, and which appears to have caused as much suffering and as great economic losses as the flood a few years earlier.

In general, catastrophies are stimulating and usually result in improvements calculated at least to minimize if not entirely to eliminate future losses at a time of recurrence.

In a review of the effect of the 1930 Drought on the surface water supplies of the State of Illinois, it is desirable to visualize from the map what municipalities use surface water and the type of source from which such water is drawn. (See figure 1.)

Lake Michigan

Bordering the northeast corner of the State the great inland sea—Lake Michigan—provides Illinois with some 60 miles of water-front. Spread out along this entire shore line are a number of municipalities of which Chicago is the largest.

Eight of these municipalities, together with Great Lake Naval Station and Fort Sheridan Army Post, secure their water supply from the lake directly, while some twenty-six more located on the

[1] Presented before the Illinois Section meeting, April 28, 1931.

[2] Engineer, State Water Survey Division, Urbana, Ill.

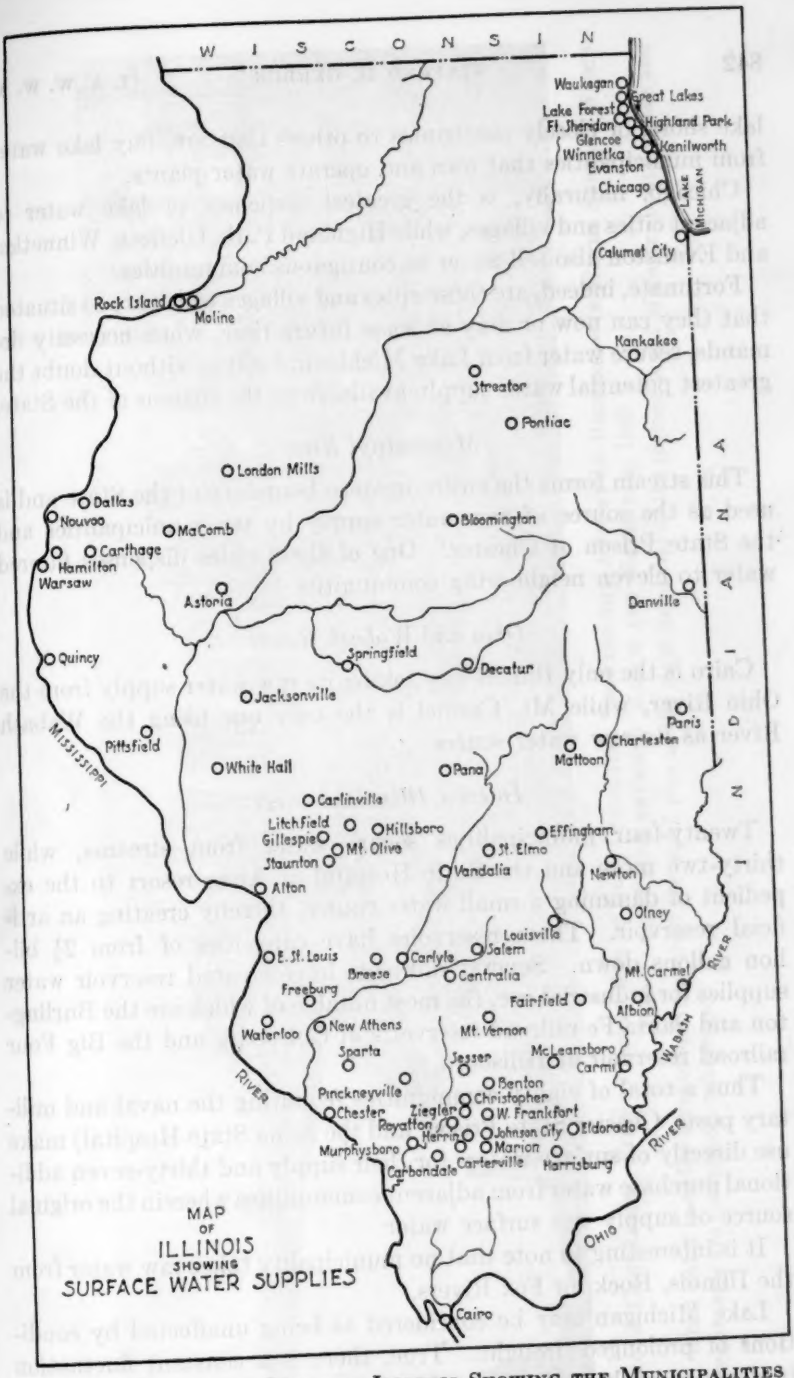

Fig. 1. Map of the State of Illinois Showing the Municipalities that Depend upon Streams, Lakes or Reservoirs for Their Raw Water Supply

lake shore, or closely contiguous to others that are, buy lake water from municipalities that own and operate water plants.

Chicago, naturally, is the greatest dispenser of lake water to adjacent cities and villages, while Highland Park, Glencoe, Winnetka, and Evanston also sell water to contiguous communities.

Fortunate, indeed, are those cities and villages which are so situated that they can now or may at some future time, when necessity demands, secure water from Lake Michigan, for it is without doubt the greatest potential water supply available to the citizens of the State.

Mississippi River

This stream forms the entire western boundary of the State and is used as the source of raw water supply by ten municipalities and the State Prison at Chester. One of these cities dispenses filtered water to eleven neighboring communities.

Ohio and Wabash Rivers

Cairo is the only Illinois city taking its raw water supply from the Ohio River, while Mt. Carmel is the only one using the Wabash River as its raw water source.

Interior Illinois streams

Twenty-four municipalities secure water from streams, while thirty-two more and the State Hospital at Anna resort to the expedient of damming a small water course, thereby creating an artificial reservoir. These reservoirs have capacities of from 2½ billion gallons down. Several railroads have created reservoir water supplies for industrial use, the most notable of which are the Burlington and Santa Fe railroad reservoirs at Galesburg and the Big Four railroad reservoir at Hillsboro.

Thus a total of eighty communities (counting the naval and military posts, Chester State Prison, and the Anna State Hospital) make use directly of surface waters for their supply and thirty-seven additional purchase water from adjacent communities wherein the original source of supply was surface water.

It is interesting to note that no municipality takes raw water from the Illinois, Rock, or Fox Rivers.

Lake Michigan may be considered as being unaffected by conditions of prolonged drought. True, there is a constant fluctuation in elevation of the surface, but this is not of sufficient extent to permit

FIG. 2. CENTRALIA. VIEW OF LOWER END OF LAKE CENTRALIA SHOWING THE AMOUNT OF RECESSION IN WATER SURFACE WHICH HAD TAKEN PLACE BETWEEN MARCH AND NOVEMBER, 1930

When water is at the level of spillway crest the small pier at the right hand end of the picture is out of water about 6 inches and tree stumps are completely submerged.

the exposure of the intakes and the disruption of the service. It is of great potential value as a source of relatively soft water. Particularly is this true for the great metropolitan area encompassed within a radius of 40 miles of Chicago.

All municipalities within this zone except those previously mentioned as bordering the lake resort to wells for their supply, but the ever increasing demands is causing a steady decline in the water table

FIG. 3. CENTRALIA. VIEW SHOWING STAFF GAGE SET MARCH 24, 1930

On that date water stood 1.25 feet below the top of the 10-foot gage. On November 13, 1930, the date the photograph was taken, the lower end of the staff gage was out of water though there was a few inches of water in the depression of the old stream bed.

so that serious consideration has been given to the construction of tunnels whereby lake water may be supplied these communities.

During the drought period the flow of the Mississippi River steadily diminished, reaching a low water record during the early months of 1931. In spite of this situation there was always sufficient water for the municipalities, although greater care was necessary in the operation of the treatment plants. The Wabash and Ohio Rivers

likewise experienced low water stages, but not to an extent sufficient to cause alarm or curtail the use of water. The low water in the Ohio, however, was responsible for an unpleasant taste at places between Illinois and Pittsburg.

In the interior of the State quite a different situation prevailed. Many of the small streams used as raw water supplies went dry, or nearly so, and a considerable number of the reservoirs reached alarm-

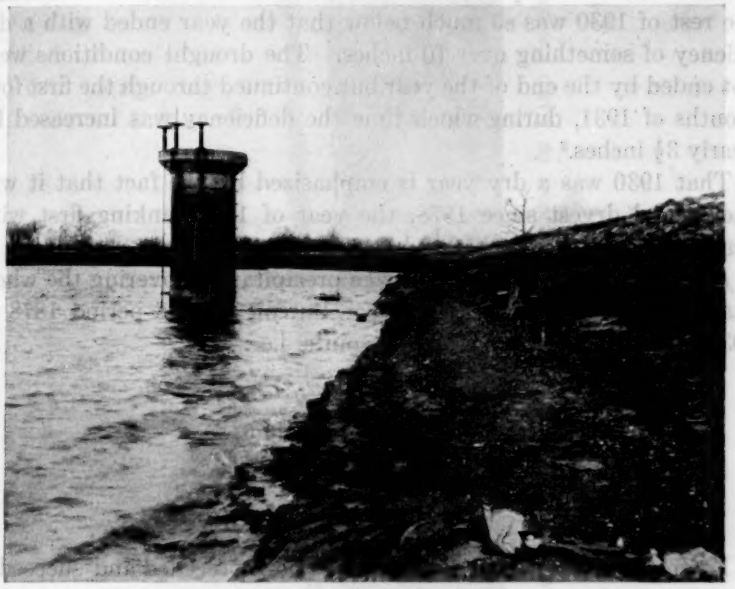

FIG. 4. CARBONDALE. VIEW LOOKING NORTH ALONG THE DAM SHOWING INTAKE TOWER

Note portion of the dam ordinarily submerged, the riprap being well above the water level. The loss in depth is clearly indicated by the difference in color on the intake tower. Photograph taken November 14, 1930.

ingly low stages. However, alarming as the situation may have been, it is now possible to visualize the entire picture and quite clearly analyze the factors largely responsible for the situation.

The Weather Bureau has conveniently divided the State into three divisions—Northern, Central, and Southern. These areas coincide very closely with the deep well, drift well, and surface water zones, as outlined by the State Water Survey Division in its studies of the water resources of the State.

Within the Central and Southern Divisions of the Weather Bureau subdivisions are to be found those municipalities which suffered the worst from a water deficiency during the past twelve or fourteen months.

Very naturally, the one factor which bulked largest in the minds of the residents in the drought-stricken area was the long period of deficient precipitation and well it might, for while January was above normal and February practically normal in the matter of rainfall the rest of 1930 was so much below that the year ended with a deficiency of something over 10 inches. The drought conditions were not ended by the end of the year but continued through the first four months of 1931, during which time the deficiency was increased by nearly 3½ inches.[3]

That 1930 was a dry year is emphasized by the fact that it was the second dryest since 1878, the year of 1901 ranking first with something more than 2 inches less rain than 1930.

A review of the figures of average precipitation covering the whole State as published by the Weather Bureau for the period 1878 to 1930 inclusive indicates four low points, i.e.:

Year	*Inches below normal*
1901	10.63
1930	8.46
1894	7.46
1914	7.36

Each of these subnormal periods was both preceded and succeeded by precipitation considerably in excess of the dry year. For instance, 1930 was preceded by an annual precipitation of 5.6 inches above normal; what the year 1931 will bring we do not know, but the first four months placed a very decided handicap upon it. However, past records seem to indicate that a total precipitation approximately equal to normal may safely be anticipated.

Accompanying the long dry summer months were many days of extreme heat, wherein the rates of evaporation were high. It is probably safe to say that the total annual evaporation for 1930 on some of the reservoirs may have reached 50 or more inches. This together with the extra demands placed on the various water supply systems due to the heat brought about a rapid lowering of stage and

[3] Figures apply only to the Central and Southern Divisions.

FIG. 5. CARBONDALE. PANORAMA VIEW OF THE LAKE SHOWING THE AMOUNT OF LAND UNCOVERED BY THE LOW WATERS
View taken November 14, 1930

reserve capacity. The lack of rainfall or replenishment in capacity and the high rates of evaporation are things the designing engineer or municipal official cannot overcome, but selection of the site and the construction of the reservoir are things over which it is possible to exercise some control.

A review of capacities, water surface area, watershed area, culture of the shed basin, together with the character of the soil and topography, seem to indicate that certain ratios may exist between these factors and that there may be a limit below which it is not safe to go.

Anticipating a trend toward impounded water supplies, the State Water Survey Division began in 1926 the study of those conditions which would furnish data desired by engineers and officials in connection with the selection of sites for reservoir construction. Each year since has seen an extension of these studies until now five municipal and one industrial water supply reservoirs are under observation. In addition to these a number of others were inspected during the past year because of their known susceptability to low water stages during period of light precipitation.

Generally speaking those reservoirs which lost capacity rapidly and increased the gray hairs for the waterworks operator and public officials were badly located. This does not mean that a better location was ignored, but rather that, as a site, the water surface area was out of proportion to the storage capacity, resulting in a shallow pond and permitting high rates of evaporation. On some of the smaller reservoirs the indications were that evaporation considerably exceeded consumption this past year.

In designing an impounded reservoir for water supply purposes it is, of course, necessary to use whatever figures on precipitation are available. However, it frequently happens that a large proportion of the annual rainfall comes at a time when the reservoir is full, or practically so, and therefore a large part of the run-off overflows the spillway and is lost. Again storms of heavy precipitation frequently occur when the ground conditions are such as to permit high rates of run-off, such as icy, frozen, or thoroughly saturated soil, and unless storage facilities are available such storms are useless for producing a water supply.

In this connection it is interesting to review briefly the 1930 rainfall on the Salem reservoir watershed. The normal precipitation for the Southern division as established by the Weather Bureau is 41.31 inches.

During the year, however, only 30.55 inches was recorded at Salem, a deficiency of 9.94 inches. Of this total of 30.55 inches 8.33 came in January and 2.53 inches in February, or a total of 10.86 for the two months, an excess of 6.73 inches above normal. For the next six months there was recorded a total of but 10.55 inches, or a deficiency of 14.29 inches. September produced a rainfall of 4.76 inches for the month, an excess above normal of 1.82 inches, while the last three months produced but 5.38, or a deficiency of 4.20 inches.

FIG. 6. WEST FRANKFORT. VIEW ACROSS A PORTION OF THE UPPER END OF THE RESERVOIR SHOWING THE LAND UNCOVERED BY THE RECESSION OF THE WATER LEVEL AND THE GROWTH OF GRASS AND WEEDS WHICH IMMEDIATELY FOLLOWED

View taken October 31, 1931

Knowing the conditions of the farm lands during the summer it is evident that but a comparatively small amount of the September rains ever reached the reservoir, even though 2.51 inches was recorded on September 15. The rains for the balance of the months were of such amounts that they were easily absorbed by the soil and hence contributed nothing to the replenishment of the reservoir.

The Carbondale reservoir is somewhat more sensitive to small rains

FIG. 7. MARION. PANORAMA VIEW OF THE DAM, INTAKE TOWER, AND SPILLWAY OF THE WATER SUPPLY RESERVOIR AT MARION TAKEN FEBRUARY 11, 1931

The loss in depth is clearly shown by the difference in color on the intake tower as well as in the amount of land uncovered between the edge of the lake and the spillway crest which may be noted just above the elevated board walk in front of the spillway structure.

as the soil is clay underlain with rock and the topography is more rugged, giving opportunity for less absorption and more run-off.

The watershed topography of the reservoirs of Centralia, West Frankfort, Staunton, Galesburg, and Bloomington is what might be termed gentle and largely given over to farming. Especially is this so for Galesburg and Bloomington.

It seems pertinent, therefore, to give much weight to the use of the land surface and to so design the storage that the reservoir may be filled at a time of the year when the land and crops require the water

FIG. 8. SALEM. VIEW LOOKING WESTERLY ALONG THE PAVED FACE OF THE SALEM RESERVOIR DAM

Difference in color on the concrete of the intake tower indicates quite clearly the loss in depth. View taken February 9, 1931.

the least. It is also evident that a comparatively small drainage area may produce plenty of water, if facilities for saving or storing it are provided.

A comparison of the area of the reservoir surface with that of the drainage basin shows that this ratio for Centralia is as 1 to 17; for Carbondale is as 1 to 16; for West Frankfort is as 1 to 16; and for Staunton is as 1 to 17.

The records further indicate that these basin areas are capable of producing much more water than the present reservoirs can retain and

with normal conditions of precipitation no shortage is experienced. Hence, it is the storage factor that is at fault under conditions of subnormal precipitation.

At Lake Bracken, Galesburg, the ratio of lake surface area to drainage basin area is 1 to 30.8, while at Lake Bloomington the ratio is 1 to 72. A relationship that indicates a rather low rolling topography and a basin area largely in excess of that required.

Perhaps no set of figures shows so quickly the reserve storage possibilities of a reservoir as the ratio between water surface area and storage capacity. This ratio for these six reservoirs is as follows:

	Ratio of water surface area to storage capacity
Centralia	1 to 3.60 million
Carbondale	1 to 2.55 million
West Frankfort	1 to 2.19 million
Staunton	1 to 2.65 million
Lake Bracken, Galesburg	1 to 4.83 million
Bloomington	1 to 4.10 million

These ratios are particularly significant from the standpoint of losses from evaporation, as they give an indication of type of storage whether deep or shallow.

Of these six supplies, Carbondale has suffered the greatest loss in water stage because the loss by evaporation and withdrawal for consumption were high. West Frankfort has the lowest ratio, but the consumption is low so that the total of evaporation and consumption has a tendency to offset the low ratio shown.

Ability of the earth structure to act as subsurface storage is a great asset. Such a condition is noticeable at Lake Bracken when the recession in water level did not exceed 3 feet for the entire drought period even in the face of a pumpage withdrawal of about 550 million gallons. The reservoir has a rated capacity of about 950 million gallons.

A summary of the physical factors at the various surface water supplies, both stream and reservoir, installations, indicates strongly that lack of capacity to store the early season rains in amounts sufficient to supply the municipalities for 18 to 24 months is the predominating weakness. It is also evident that the ratio of water surface area to storage is of greater significance than the ratio of water surface area to drainage basin area.

A satisfactory and practically unlimited supply of water is condu-

cive to high consumption, hence the storage should be ample to protect the owner against a twelve months' drought with a large factor of safety.

Water is a valuable asset to any Illinois community. The additional cost required to construct an adequate supply over that for a lesser project is very small when considered in terms of insurance. No household commodity is as cheap as water no matter what the price.

DISTRIBUTION SYSTEM FACTS AND FANCIES[1]

By Clarence Goldsmith[2]

Discussions of water distribution systems, both in general and in detail, have been almost as widespread as the use of water itself, and I am tempted to add, almost equal in volume. I find it difficult to offer anything new or original and, therefore, must confine myself to the effluent of a subject familiar to all of you who make a practice of attending waterworks gatherings or reading waterworks publications. My system of treatment and filtration has removed a great amount of the solid matter usually presented to you on this subject, and if you are interested in thorough analyses, from a fire protection viewpoint, I cheerfully refer you to the following papers appearing under my name, except as noted, in the Journal of the American Water Works Association, wherein may be found some ideas coagulated by experience and well settled in the still basin of Time:

"Methods of Making Flow Tests and Their Value to Water Works Engineers," by Geo. W. Booth, Chief Engineer of The National Board of Fire Underwriters, October, 1924;

"The Relation of Fire Protection Requirements to the Distribution System of Small Towns," October, 1924;

"Municipal Water Works Systems and Public Fire Protection," February, 1929;

"Pump Discharge Headers and Pump Piping for Water Works Stations," by F. G. Cunningham of Fuller and McClintock, Engineers, January, 1930;

"The Use of Pumpers at Fires," January, 1930;

"Maps and Field Records," by Edgar K. Wilson, Chief Engineer, The Pitometer Company, June, 1931;

"Objectionable Features Commonly Found in Water Works Systems," by Frank R. Daniel, Chief Engineer, Fire Insurance Rating Bureau, March, 1932.

After filtering, I find in the effluent some evidence of the need of further treatment of good old ideas to bring out their potability and

[1] Presented before the Illinois Section meeting, April 12, 1932.

[2] Assistant Chief Engineer, The National Board of Fire Underwriters, Chicago, Ill.

of new ideas that may result in a smoother product. These ideas float through the distribution system and I shall ask that you skip with me from floc to floc without attempting to keep them in any studied order or coherence. Like the wedding finery of the old-fashioned bride, they include:

"Something old, something new;
Something borrowed, something blue."

The pirates of old buried treasure underground and made maps to show where to find it. Some kept their maps safely and lived to become respected gentlemen of leisure. Some lost their maps and spent their lives in search of the buried fortune. Some made no maps, relying upon memory, and died unexpectedly, without divulging the secret. Foolish pirates! Today, untold millions of dollars are buried in the streets of American cities, crews of workmen prowl the highways, digging up pavements, obstructing traffic, searching for treasure buried and lost without maps, and when the treasure is found, it is buried again and lost, because many water departments have not yet learned that maps and records of underground structures often are more valuable than the structures themselves. Foolish pirates!

Some treasures rot in the ground. Costly garments, weapons of finest craftmanship, watches and pearls rust and decay because they are left unused and uncared for. Valves rust, clog, packings dry out, leaks wear away the parts, unknown to the superintendent who does not believe in regular tests and inspections, until some day a city is lost because an important valve will not operate to shut off a main broken in a conflagration or because it has been carelessly left closed.

REGULAR INSPECTIONS OF VALVES AND HYDRANTS

Do these comparisons sound fantastic? How much does it cost to install a new service, and how much does it cost to locate a service that has been lost? What is the cost of regular inspections of valves and hydrants compared with the possible destruction of an important building or group of buildings? Has it occurred to you that your water company or department may be held liable for a loss by fire if it can be proved that a defective hydrant or valve prevented or delayed the extinguishment of the fire? Some courts have held that it is the duty of a water utility to supply a sufficient volume of water to extinguish any fire in the area covered by the distribution system, but others less radical have held that the utility is liable only for the ef-

ficient operation of the system as installed, including the supply works. Fortunately for most public utilities, this principle has not usually been applied except where there is public animosity toward privately-owned utilities.

Valves and hydrants are provided mostly for use in emergencies, principally emergencies due to fire, or due to the necessity of repairs to the system. Valves used frequently in the normal operation of supply works and the control of flow to certain districts usually are maintained in good condition simply because the necessity becomes evident whenever they are used, and authorities are subconsciously nagged into action. There is no nagging demand for attention from a valve or hydrant that may not have been used for years, so they are neglected by superintendents and foremen lacking forethought or conscientious regard for their responsibility. A remark recently made by a superintendent illustrates a too common attitude: "I know those valves are in poor shape, but they would only be used in an emergency, and I don't bother them." An emergency is defined as "a sudden or unexpected situation demanding prompt action." How on earth can anyone expect to cope with an emergency by prompt action when prompt action is made impossible by neglect to maintain valves and hydrants in good operating condition? You would not consider me unduly emphatic regarding the care of valves and the recording of their operation and location if you could go through fire reports and correspondence in our files and note the frequence of the old story, "a break in the 24-inch main on Whoozis street could not be shut off because when an attempt was made to shut a controlling valve, the stem was twisted off. By the time other valves could be found and closed, the fire had developed beyond control and the fire department devoted its efforts to saving surrounding property." No superintendent, no matter how good his supervision and organization, can say with certainty that all valves, supposed to be open, actually are open. In at least one case, to my personal knowledge, a 12-inch valve closed itself. The valve box was almost in contact with the rail of a much used railroad track, and vibration from passing trains undoubtedly caused it to close. It was discovered after an investigation of the cause of a gradual increase in pressure at the pumping station and when found, the stem was so loose that it could be operated with one finger. Gates sometimes slip off the stem, workmen late in the day sometimes open one valve to restore service to a closed section, intending to return "tomorrow" to open the rest, and forget. Check

and recheck, if you would be sure. In small systems, especially where valves are few, even a small valve closed may be a serious matter. Many miles of pipe have been laid unnecessarily to strengthen sections weakened by unknown closed valves. However, waterworks men are not the only ones who bury their mistakes.

STOCKING REPAIR PARTS

Another item is often overlooked by the water department pinched for funds, and that is the importance of maintaining repair parts and extra pipe and specials in the pipe yard. Cast-iron pipe will break, even when under no pressure, from obscure causes. It does not often happen, but it does happen with sufficient frequency to warrant the command, "Be prepared!" I know that the Underwriters are considered unduly apprehensive in asking duplication of low-pressure piping in pumping stations, and elsewhere, but "believe it or not," many an emergency has resulted in disaster or serious trouble because some pipe that could not break has broken. While I am on that subject, let me call particular attention to a valuable paper previously mentioned, "Pump Discharge Headers and Pump Piping for Water Works Stations" by F. G. Cunningham. "Read it and weep" when you look over some piping layouts, your own or some other fellow's!

DISTRIBUTION SYSTEM DESIGN

The design of distribution systems is a subject covered so often that there is little that I can add, but there are a few new or little known ideas that may be the solution of some of your problems. You probably know that 4-inch pipe should not be used for hydrant supply, and that a distribution system made up entirely of 8-inch pipe needs no larger feeders in all except the most congested mercantile, manufacturing, or apartment house districts. If you have runs of 4-inch pipe in a gridiron and cannot replace all of them at once, try the stagger system of replacement, laying 8-inch pipe in alternate blocks, so that all hydrants will have connections to the larger pipe. This system is not so good as a complete replacement, but it does spread your possible improvement over a greater area. If your blocks are long, with hydrants in the middle, lay the 8-inch from alternate intersections each way to the midway hydrants.

Connecting existing minor distributors to new feeders always presents a problem. The system most often used is to insert a cross. I believe that a better system is to use a run-around cross-connection,

with two valves in the cross-connection, so that the repair of one valve will not put both mains out of service. It is a good system even when all mains are new, because it eliminates temporary dead ends when sections are shut off for repairs. A variation of the same idea is superior to the usual construction on boundaries between high and low services. Construct that part of your distribution system in loops around alternate blocks, checker-board fashion, and connect the adjacent high- and low-service loops with cross-connections having two valves, one normally closed for the separation of services. This system eliminates the dead ends usually formed at service limits and is less expensive than laying both high- and low-service mains in the same boundary street. Sometimes valves are opened slightly to allow a small flow from a higher service to a lower or to provide circulation. This results in wear and troublesome maintenance. A better practice would be to install a small by-pass, in which the valve could be left open.

You all probably have had experience with flow tests made of your own systems when the Underwriters visit you for periodic inspections. Mr. Booth's article, previously mentioned early in this paper, describes the method of making these tests and the benefits that you can obtain by making such tests yourself. I recommend it for your earnest perusal. Flow tests may save you time, trouble, and much unnecessary expense. I think so highly of flow tests that I consider them the greatest single value in our reports on water supply.

WATER RAM

Before closing, I want to comment on my pet peeve against the waterworks fraternity. Members persist in miscalling humps in water pressure "water hammer." Water hammer is very rare in waterworks operation, being created only when a vacuum is present. What we so often hear called water hammer is not water hammer, but is "water ram." Water ram is the increase in pressure caused by the sudden stoppage or decrease of flow, such as occurs when a hydrant or a shut-off nozzle is closed quickly. It may seem from the reading of this paper that I have many peeves against waterworks practice. I have not, but occasionally I like to get them all together and "shoot the works." Waterworks men are long-suffering, usually capable of obtaining much better results than circumstances, mostly financial, will permit. I hope that I have not caused you any more suffering, but if I have, that you will consider that "it must have been two other fellows."

SOAP CONSUMPTION AND WATER QUALITY[1]

By H. W. Hudson[2] and A. M. Buswell[3]

For centuries man has been interested in quality of water. Today the question of quality does not stop with health considerations. We want to know the comparative values of hard and soft water. Is soft water more economical to use? If there is a saving in its use, what is the extent of that saving and in what connections are savings accomplished?

Answers to these questions are of special interest to people who see industries pass up good locations in their city, to take advantage of a better water supply in some neighboring city, or perhaps some city far away. Water which a city supplies to its citizens for use in the home also plays no small part in municipal development. Other things being equal, American people prefer to live where they can have good water.

Studies have been made to determine the effects of quality of water used in industry, especially the textile and paper industries. Railroad companies have determined comparative costs of using various types of water in their locomotives. The Laundryowners National Association has determined the soap waste in commercial laundries due to hard water. They find that it pays to install some type of water softener, if the only water supply available is of poor quality.

The present study deals with the effect of quality of water on soap consumption in the home. To obtain the desired information concerning this problem, a market survey of retail soap distribution has been conducted in cities having different types of water.

SCOPE OF STUDY

Surveys of retail soap sales have been made in Chicago Heights, Bloomington, and Champaign-Urbana, Illinois, and Superior, Wisconsin. Chicago Heights has the hardest water of any city in Illinois,

[1] Preliminary report presented before the Illinois Section meeting, April 13, 1932.

[2] State Water Survey, Urbana, Ill.

[3] Chief, State Water Survey, Urbana, Ill.

averaging around 555 p.p.m. total hardness. Bloomington, having relinquished her claim to having the hardest water in the state, now has a water supply of good quality. In addition, this water is softened and reaches the consumer at an average hardness of approximately 70 p.p.m. or softer than cistern water. Many people in Bloomington are still using cistern water, however, either from habit or because they do not care to change their plumbing so long as it is in good condition. The Champaign-Urbana water supply is considered to be of about medium quality and averages 298 p.p.m. total hardness.

Superior, Wisconsin, has been included in the study because of the naturally soft water supply available. This is true not only of the city of Superior, but the surrounding trade territory has the same general type of water. The total hardness averages not over 45 p.p.m. Thus the results are not affected by cisterns, water softeners, or any appreciable variation in type of water used throughout the area considered. It has been suggested that less soap is required in a cool climate than in a warmer climate, but the results from communities in Illinois which use soft water do not warrant such an assumption. For example, the difference in soap consumption in Superior and Bloomington is scarcely, if any, greater than would be expected with the difference of 25 p.p.m. total hardness in their water supplies. Any surplus difference may fairly be attributed to the continued use of rain water in Bloomington.

Considering all factors then, Superior seems to be the most satisfactory base to which to compare other cities. It would be impossible to find a city having a water supply of zero hardness. It would be impractical, no doubt, to soften water to a point below that of the Superior supply. Some claim that it is impractical to soften water to below 70 p.p.m. This does not mean that there would be no added saving in soap in so doing, but rather that beyond a certain point the cost of softening increases more rapidly than the hardness decreases.

All kinds of soaps and soap products sold at retail in the various cities are included. Results are given in weights as well as in dollars in order that they may be significant regardless of price changes in the future.

Commercial laundries have not been included in the study because most of them now use soft water in their work regardless of how hard the city supply may be. Industrial use of soap has also been ex-

cluded because industries vary from city to city. Certain industries use considerable quantities of soap while others use none.

METHOD

The personal interview method was used to collect the data. A thorough canvas of each city was made to find every retail store handling soap. Each of these retailers was approached by a personal investigator and asked to furnish the desired information. Although this method seemed the most practical, certain difficulties were encountered.

It was impossible, for example, to obtain 100 percent returns in any city. Each city sells a greater or less amount of soap to the surrounding trade territory. The extent of the trade territory is influenced by local conditions. In the case of Bloomington the type and quality of water used in the surrounding area is quite different from that used in Bloomington. Many cisterns and water softeners are used in Chicago Heights and Champaign-Urbana. These facts have been taken into consideration and the original data corrected for error accordingly.

RESULTS OF THE INVESTIGATION

As indicated by table 1, Superior uses 27.5 pounds of soap per capita annually. Even with this relatively very soft water which contains only 45 p.p.m. total hardness, a considerable quantity of soap is required to remove dirt and grease. Water alone will not do the work. If it were possible for a city to obtain a water supply of zero hardness, it would still use probably between 20 and 25 pounds of soap per capita, annually.

Compared to Superior's soap consumption of 27.5 pounds, Bloomington with its slightly harder water, 70 p.p.m., uses 30.8 pounds per capita while Champaign-Urbana and Chicago Heights use 37.9 and 44.9 pounds respectively with their waters of 298 and 555 p.p.m., total hardness. The per capita cost in these four cities are in order: $3.60, $4.20, $5.58, and $7.27.

An interesting and valuable check on this investigation is found in data obtained from the Illinois Masonic Home at Sullivan, Illinois. Results are shown in table 2. A water softener was put into use the latter part of July, 1929. It reduced the total hardness of the water supply from 206 to 3.5 p.p.m.

From October 1, 1928, to October 1, 1929, the per capita soap con-

sumption at the home was 40.4 pounds. During the next 12 months it amounted to 45 pounds. From October 1, 1930, to October 1, 1931, it was reduced to 29.4 pounds. The per capita costs of these three periods were $3.85, $4.10, and $2.59 respectively. The relatively low cost per pound for soap at the home is due to quantity purchase.

TABLE 1

Per capita soap consumption for cities supplied with different types of water

CITY	POPULATION	TOTAL HARDNESS OF WATER SUPPLY, P.P.M.	ANNUAL PER CAPITA SOAP CONSUMPTION, POUNDS	ANNUAL PER CAPITA COST OF SOAP, DOLLARS
Superior, Wisconsin	36,113	45	27.5	3.60
Bloomington, Illinois	30,930	70	30.8	4.20
Champaign-Urbana, Ill	33,408	298	37.9	5.58
Chicago Heights, Illinois	22,321	555	44.9	7.27

TABLE 2

Per capita soap consumption for Illinois Masonic Home with different types of water

PERIOD	NUMBER OF PEOPLE LIVING AT THE HOME	TOTAL HARDNESS OF WATER SUPPLY, P.P.M.	ANNUAL PER CAPITA SOAP CONSUMPTION, POUNDS	ANNUAL PER CAPITA COST OF SOAP, DOLLARS
10–1–28 10–1–29	285	206	40.4	3.85
10–1–29 10–1–30	285	206	45.1	4.10
10–1–30 10–1–31	290	3.5	29.4	2.59

The 4½ pound increase in the second period is hard to account for. It will be noted that this period overlapped the use of soft water by two months. Many residents of Bloomington contend that for several weeks after the installation of their water softener, soap was really wasted instead of saved. They say that soft water dissolves soap much more rapidly than does hard water. Consequently, until people became accustomed to using soft water, more soap was used with it than with hard water. This may in part account for the

increase in soap used at the Masonic Home during the second period.

Some question may be raised as to why the Masonic Home used more soap per capita with water testing 206 p.p.m. total hardness than does Champaign-Urbana with water testing 298 p.p.m. The answer is, in part at least, that all laundry work is done at the Home, whereas much of that work in Champaign-Urbana is done by commercial laundries, which are not included in this study. Then, too, the average cleanliness of the people at the Home may be above the average cleanliness for all classes of people in Champaign-Urbana.

Again it may be pointed out that the Home uses more soap per capita with water of 3.5 p.p.m. total hardness than does Superior with water testing 45 p.p.m. The same reasoning applies here as

TABLE 3

Waste of soap per capita due to hardness of water

Superior soap consumption used as base for comparison

CITY	TOTAL HARDNESS OF WATER SUPPLY, P.P.M.	ANNUAL PER CAPITA SOAP WASTE, POUNDS	ANNUAL PER CAPITA SOAP WASTE, DOLLARS	PERCENT OF WEIGHT OF SOAP WASTED	PERCENT OF COST OF SOAP WASTED
Superior, Wis	45	Base	Base	Base	Base
Bloomington, Illinois	70	3.3	0.60	10.7	14.3
Champaign-Urbana, Ill	298	10.4	1.98	27.4	35.5
Chicago Heights, Ill	555	17.3	3.67	38.6	50.4

in the case of Champaign-Urbana. An additional factor entering here, however, is that with one exception at the Home, only the water from the hot water faucet is soft. When the soft hot water is cooled with cold hard water the total hardness is increased.

Taking Superior as a base for comparison the per capita soap waste as indicated by table 3 is 3.3 pounds for Bloomington. These 3.3 pounds of waste soap cost the Bloomington citizen 60 cents and amounts to 10.7 percent of his total soap purchases. The annual per capita waste of soap in Champaign-Urbana is 10.4 pounds which costs $1.98 and amounts to 27.4 percent of the total now consumed. Chicago Heights, with its water supply of 555 p.p.m. total hardness, wastes annually 17.3 pounds of soap per capita which costs $3.67 and amounts to 38.6 percent of the total soap used.

Taking the soap consumption at the Masonic Home while soft

water was being used as a base for comparison, the soap waste for the period October 1, 1928, to October 1, 1929, was 11 pounds and cost $1.26. The percentage of waste was 27.2 or practically the same as that for Champaign-Urbana. For the next 12 months or the period overlapping the installation of the water softener, the waste was 15.6 pounds, which cost $1.51 and amounted to 34.7 per cent of the total consumption.

TABLE 4

Waste of soap per capita at the Illinois Masonic Home due to hardness of water before the installation of a water softener

PERIOD	TOTAL HARDNESS OF WATER SUPPLY, P.P.M.	ANNUAL PER CAPITA SOAP WASTE, POUNDS	ANNUAL PER CAPITA SOAP WASTE, DOLLARS	PERCENT OF WEIGHT OF SOAP WASTED	PERCENT OF COST OF SOAP WASTED
10–1–30 10–1–31	3.5	Base	Base	Base	Base
10–1–28 10–1–29	206	11.0	1.26	27.2	30.7
10–1–29 10–1–30	206	15.6	1.51	34.7	57.9

TABLE 5

Total waste of soap due to hardness of water

Superior soap consumption used as a base for comparison

CITY	POPULATION	TOTAL HARDNESS OF WATER SUPPLY, P.P.M.	TOTAL WASTE			
			Per day		Per year	
			Pounds	Dollars	Tons	Dollars
Superior, Wisconsin	36,113	45	Base	Base	Base	Base
Bloomington, Illinois	30,930	70	280	50.28	51	18,332
Champaign-Urbana, Ill	33,408	298	950	180.67	173	66,148
Chicago Heights, Ill	22,321	555	1,060	224.43	193	81,918

The significance of these wastes may be brought out more clearly by stating the total waste for each city. Table 5 shows this by both quantity and value and both per day and per year. The total daily soap waste for Bloomington is 280 pounds costing $50.23. This means that by taking out 25 p.p.m. more mineral from the water, Bloomington could save $50.23 per day in addition to their already

enormous saving from what they used to waste with their former water supply. In a year's time this small saving would amount to 51 tons of soap or $18,332.

It is impossible to obtain data showing Bloomington's soap consumption before she obtained her present water supply of high quality. Since the former water supply was approximately 100 p.p.m. harder than the present supply of Chicago Heights, it will be conservative to take the difference in soap consumption of Superior and Chicago Heights as Bloomington's former soap waste over what she now uses. The difference between Superior and Bloomington water is 25 p.p.m. On this basis Bloomington is now saving, due to her relatively high quality of water, 1469 pounds per day, which amounts to $30.24. For a year this saving would total 268 tons or $113,507.

Champaign-Urbana, with her water of medium quality, is wasting 950 pounds of soap per day which amounts to 173 tons per year. The value of this wasted soap is $180.67 per day or $66,148 per year.

Chicago Heights, having the hardest water of any city under consideration, 555 p.p.m. has not only the highest per capita waste, but also the greatest total waste. The total waste per day for this city, due to its extremely hard water, is 1060 pounds of soap or $224.43. In a year's time this amounts to 193 tons of soap which costs $81,918.

In the past, chemists have estimated the effect of quality of water on soap consumption. Various authorities have estimated that, in a town of 40,000 inhabitants using a water of 300 p.p.m. hardness, a ton of soap is wasted per day. These estimates were made before the day of the home water softener and included all soap uses within a city. Results of the present study indicate that a city of 40,000 inhabitants is wasting 1140 pounds of soap per day for domestic purposes alone. This would seem to indicate that the estimate of chemists is not far from correct.

CONCLUSION

In conclusion, it may be stated that, beyond a certain minimum necessary even with the softest of waters, soap consumption varies as the hardness of the water. Beyond medium hardness, however, the facts obtained indicate that the increase in soap consumption is not in direct proportion to the increase in hardness of the water used. This fact is borne out by laboratory tests.[4]

[4] Buswell, A. M.: The Chemistry of Water and Sewage Treatment, p. 80.

Facts presented indicate that a city water supply of high quality gives to the citizens of that city a certain advantage in economy of soap requirements. Whether or not it will pay a city having a water supply of poor quality to gain that economy and other advantages connected with it, will depend upon the cost of obtaining an improved water supply.

THE STANDARDIZATION OF SPECIFICATIONS FOR MATERIALS AND EQUIPMENT[1]

By F. M. Randlett[2]

Standardization is essentially the bed-rock of civilization. The origin of standardization goes back to the crude beginning of human culture. The earliest records of which we now have any knowledge were the standards of weights and measures of ancient Babylonia and Egypt. The Ten Commandments are basic standards of modern ethics. Barter and trade developed a standard medium of exchange or money. The development of these early standards to the present methods of effecting commercial transactions is a history of interest and value that cannot be covered here.

In this brief introduction I simply wish to emphasize that standardization has been essential to the development of our civilization and is particularly necessary now if we are to advance in the next decade at the pace we have in the past. No one can doubt that the standardization, of materials, of machines, of processes, and of products of manufacture, has been one of the prime aids to American progress.

Before proceeding directly to my subject I feel it necessary to emphasize three matters that should be given careful consideration by all engineers preparing specifications and contracts. First, the use of standard terms, abbreviations, symbols, constants, and other nomenclature. We engineers must use a standard language to be properly understood. Second, our specifications, contracts, and other technical procedure must not overlook dimensional standards that have been set for various commodities of which mention might be made of bolts and nuts, pipe flanges, fittings, etc. Third, we should follow a standard form in the preparation of contracts and specifications so that nothing is overlooked and that important general matters such as responsibility, payments, etc., are legally covered.

[1] Presented before the California Section meeting, October 29, 1931.

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With these matters so briefly disposed of, we approach the subject "Standardization of Specifications for Materials and Equipment," as follows.

GENERAL

We probably will never reach the point where standardization of specifications can extend to the complete specifications for a project. Standard specifications cannot conceivably replace the service furnished by the water works engineer in drawing up a specification in a contract form for a water works installation. This is manifest, as geographically, geologically, biologically, and logically, conditions are different. However, the standardization of specifications for materials and equipment is of prime importance to the water works engineer in enabling him to fit into his project, standard materials and equipment; that make it possible for him to turn out a finished installation with a maximum of efficiency, hydraulically, mechanically, electrically, and financially. The recognition and use of such standard specifications enable him to concentrate his attention on the planning of the installation and the development of specification requirements for such materials and equipment as may not yet be covered by standard specifications. If you will please accept this view of the way of using standard specifications, you will recognize that the work of the engineer is far from weakened by his use of standard specifications. His operation is definitely strengthened as he is using the judgment of the entire engineering profession.

THE DEVELOPMENT OF STANDARD SPECIFICATIONS

The use of the word "standard" naturally raises the question—what is a standard specification? Primarily a standard specification is a specification adopted as standard by some party. First, a specification may be a standard of one consumer or it may be that of one manufacturer where a specialty is involved. When such a specification is found effective its use naturally extends to other consumers as a result of the Brotherhood of Engineers. When it has spread this far, the association of consuming interests, such as our own American Water Works Association, may advance the specification to a standard of that association. By that time, the standard reaches recognition in trade from the manufacturing point of view. The material or equipment is used in other industries. The next stage is that represented in the activities of the American Society

for Testing Materials which represents the collaboration of various consuming interests with producing interests in the standardization of material specifications. Beyond this, we have the final national classifications of the American Standards Association.

It is the purpose of the American Standards Association to serve as a clearing house through which trade associations, technical societies or governmental departments can develop national standards. Today, the American Standards Association is essentially a federation of forty-five national technical societies, trade associations and Federal Government Departments. In the formulation of their Sectional Committees to which are assigned the standardization of particular materials or equipment, it is necessary that they appoint representatives from consuming and producing interests that use or manufacture such materials or equipment in the United States.

It is not necessary for the water works engineer to use only such standards as have been advanced to American Standards Association approval. To use the advantages of standardization, the standards of any individual engineer, any trade association, technical society, or government department can be taken. They are all based on careful study and serve a definite purpose, that is valuable when properly applied to your uses.

Even with the greatest possible use of existing standards, there will be many materials and equipment items on which you individually must sooner or later commence to set your own individual standards, putting them in line for group use, association use, and eventually national standard use. To do this you will continually have work to do in the formulation of specifications. In the preparation of any such specifications, there are certain major matters that are worthy of mention.

1. A specification for a product should contain the fewest possible restrictions, consistent with obtaining the material desired.

2. The service which the product is to perform, in connection with reasonably feasible possibilities in its manufacture, should determine the limitations of a specification.

3. All parties whose interests are affected by a specification should have a voice in its preparation.

4. Excessively severe limitations in a specification are suicidal. They lead to constant demands for concessions, which must be made if the work is to be kept going, or to more or less successful efforts at evasion. Better a few moderate requirements rigidly enforced,

than a mass of excessive limitations, which are difficult of enforcement, and which lead to a constant friction and sometimes to deception.

5. There is no real reason why a specification should not contain limitations derived from any source of knowledge. If the limitations shown by physical test are sufficient to define the necessary qualities of the material, and this test is simplest and most easily made, the specifications may reasonably be confined to this. If a chemical analysis or a microscopic examination, or a statement of the method of manufacture, or information from all four, or even other sources, are found useful or valuable in defining limitations, or in deciding upon the quality of product furnished, there is no legitimate reason why such information should not appear in the specifications. Neither the producer nor the consumer has a right to arrogate to himself the exclusive right to use information from any source.

6. Proprietary articles and commercial products made by processes under the control of the manufacturer cannot, from the nature of the case, be made the subject of standard specifications. The very idea of a specification involves the existence of a mass of common knowledge in regard to any product, which knowledge is more or less available to both producer and consumer. If the manufacturer or producer has opportunities, which are not available to the consumer, of knowing how the variation of certain constituents in his product, will affect that product during manufacture, so also does the consumer, if he is philosophic and is a student, have opportunities not available to the producer, of knowing how the same variation of constituents in the product will affect that product in service under special conditions with which he is familiar, and it is only by the two working together and combining the special knowledge of each, that a really valuable specification can be made.

7. A complete workable specification should contain the information needed by all those who must necessarily use it in obtaining the product desired.

8. Where methods of testing, analysis, or inspection are well known and understood, it is sufficient if the specification simply refers to them. Where new or unusual tests are required, or where different well-known methods give different results, it is essential to embody, in the specification, sufficient description to prevent doubt or ambiguity.

9. All specifications in actual practical daily use need revision from time to time, as new information is obtained, due to progress in knowledge, changes in methods of manufacture, and changes in the use of products. A new specification, that is one for a product which has hitherto been brought on the reputation of the makers and without any examination as to quality, will be fortunate if it does not require revision in from 6 to 10 months after it is first issued.

10. A complete workable specification for a product represents a very high order of work. It should combine within itself the harmonized antagonistic interests of both the producer and the consumer, it should have the fewest possible requirements consistent with securing a satisfactory product, should be so comprehensive as to leave no chance for ambiguity or doubt, and above all, should provide for inspection and tests that will protect the consumer in his purchase.

There is at present a distinction existing between standard specifications for materials and standard specifications for equipment. In our consideration of both of these subjects, we will confine our attention to engineering materials and engineering equipment.

STANDARD SPECIFICATIONS FOR MATERIALS

Standard specifications for materials are essentially standards of quality involving test requirements that indicate a proper measure of usefulness. In addition to quality requirements they should include provisions that will result in a high standard of usefulness in their application. Such items are tolerances, workmanship, and inspection provisions. Not only should material comply with certain stated quality requirements but should comply with standards of first-class workmanship in all particulars. When materials are bought in considerable quantities or where they are vital construction materials, or where they are materials essential to the continuous operation of a plant or machine, or when their failure in service will involve danger to human life or probable service or where failures may result in appreciable monetary loss, such material must be most thoroughly inspected. Otherwise the preparation of any specification is superfluous. Inspection of such materials can best be done and most effectively accomplished at the point of manufacture by direct representatives of the consumers, and provisions in the specifications must be made for such inspection. A standard paragraph for this requirement is as follows:

"The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturers works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works."

Some have expressed opinions that this clause should be a little more definite as to furnishing facilities for examination of the finished product for surface defects and checking of dimensions and weights. Some have even advocated that the acceptance as to quality shall be final when inspection is made and tests have been fulfilled.

There are other materials used in less quantity and not so vital to the operation of a plant or to safety that may not require detailed inspection. In general, the inspection and test of such material is accomplished by arranging for periodical tests on samples taken at random from deliveries made. No standard specification is satisfactory to a consumer unless the material furnished under it is regularly and constantly being tested in accordance with the requirements of said standard specifications.

Inspection and tests are a fundamental adjunct to the entire program of standardization and, as a matter of fact, to any successful engineering construction.

STANDARD SPECIFICATIONS FOR EQUIPMENT

The general term of "equipment" covers a large field—from small devices to the largest mechanical and electrical equipment. Generally speaking, the equipment represents the development of individual manufacturers. A standard specification cannot be extended to the same detail as can material specifications. There are, however, important points in connection with the specifications for equipment that should be carefully considered. Specifications for operative efficiency for machines and devices, known as standards of performance, specifying the factors involved in terms susceptible of measurement. Numerical statement of speed, uniformity, output, economy, durability, and other factors which together define the net efficiency of an appliance or machine.

It is also important to specify that materials used in the construction of such equipment must be furnished to standard material speci-

fications so that proper standards of materials shall be used in the construction thereof. In drafting such specifications, research data from experiments may include any or all of the following.

(a) Listing the functions to be served.
(b) Measuring the elements which serve each item of use.
(c) Setting the 100 percent efficient performance.
(d) Defining the basis of acceptance.
(e) Devising means to measure each factor pertinent to the service.
(f) Including specifications for performance or duty tests.

The requirements for the large field of equipment makes it practically impossible to give a more comprehensive picture of the method of arriving at sound and comprehensive specifications for equipment. Mention, however, might be made of the fact that municipal, state, and government codes and regulations should be studied for the technical regulation of the construction and installation. Such codes provoke efficiency and convenience in the maintenance and operation of the equipment with fire protection and safety provisions.

To much the same extent as on materials, specifications for equipment should include provisions for inspection and tests so that the inspector representing the consumer on vital equipment can see that proper materials are used and that they are fabricated in a first-class workman-like manner. Tests of completed equipment when not of large size can be accomplished at point of manufacture, but on large power or pumping installations due provisions should be made for duty or performance tests after installation. These duty tests should be conducted under the direct control of the consumer or representative and be the basis of final acceptance and payment for the equipment.

Many of the standard specifications cover requirement of a device or piece of equipment in general as to dimensions and capacity only. To such specifications must be added such definite and concise statements as will make it evident what requirements must be met as to strength, durability and efficiency of operation.

Avoid general clauses that are not definite as they are usually matters of opinion often impossible of enforcement and probably illegal.

CONCLUSION

The development and use of standard specifications is a matter of vital importance to progress. We are all in the public service working

for the welfare of civilization. We are using the peoples' money to do this. By developing and using standard specifications, we engineers will keep abreast of this age of scientific advancement. The net result will be materials, equipment, and installations that will give the maximum of usefulness, serviceability and efficiency—a maximum utility at a minimum cost.

REFERENCE

Standards and Standardization. Norman F. Harriman.

SANITARY SPECIFICATIONS AND CONSTRUCTION FOR WATER WELLS[1]

By Clarence W. Klassen[2] and Harry F. Ferguson[3]

During the past few years Illinois has experienced several serious water-borne epidemics of dysentery and typhoid. Several other supplies were polluted, but fortunately the governing officials acted upon recommendations of the sanitary engineers in time to remove the cause of pollution or to chlorinate the water and prevent serious outbreaks.

A few of these pollution cases stand out as "classic" examples of well pollution. The importance of the protection of this particular type of water supply is often overlooked by some waterworks men. A well might be so located and constructed so that at any time it could become polluted, yet the fact that it has not caused any water-borne illness develops a false sense of security in those responsible for the supply. With some the erroneous impression still prevails that the mere fact water is being pumped from a well gives definite assurance of its safety.

In Illinois 508 municipalities have public waterworks systems which are supplied from 470 sources, some cities obtaining their supplies from other cities. The importance of wells and their construction and protection, as sources of public water supplies will be appreciated when it is noted that 371 of these sources are wells. Because of the common use of the automobile and the increased travel to and visiting in cities, the safety of public water supplies is of vastly more concern than just to the cites served by them. Combined with this travel and the geographical distribution of such well water supplies, not only one community or one state, but many states are affected by the safety of public supplies. Because wells play such an important part it is imperative that waterworks men not only

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maintain them properly, but that they also give attention to the proper location and construction of such sources when they are installed so that a clear, clean, safe water will be assured.

The Division of Sanitary Engineering makes inspections of all the Illinois public water supplies. These inspections reveal that in some instances considerable thought was given to the location and construction of wells. In others apparently the same type of thought was exercised in locating wells as is practised in India, where it is reported that, in deciding upon a well's location, several buckets of water are first thrown upon a goat which is considered a sacred animal. The goat is then set free to run and is followed by the townsfolk. Wherever the goat first stops to shake himself, that point marks the location of the well, whether it is in a field or the center of main street. In many unsatisfactory wells thoughtlessness, carelessness and false economy often control. In some cases wells are finished and equipped or covered in such a manner that improvements necessary to protect them against contamination become difficult and expensive.

Many of the unsatisfactory conditions are caused by neglect in operation, but in most cases the defects allowing the entrance of contamination could have been prevented and eliminated when the wells were installed. The ignorance of the well contractor in necessary sanitary precautions or of the engineer or municipal official in not including in the specifications sections covering the proper sanitary construction may be responsible.

To prevent rather than to correct such conditions has been the aim of the State Health Department. It is not only easier, but more satisfactory to prevent than to correct and, therefore, municipalities, waterworks officials, engineers and well contractors are being advised and urged to prevent conditions in water wells which might cause pollution of supplies and resulting epidemics. Pursuing this policy, about three years ago, a suggestion by the State Sanitary Engineers to the Professor of Sanitary Engineering at the University of Illinois, brought about the organization of the Illinois Water Well Drillers Association and through the medium of their annual meetings it has been possible to inform and advise this group regarding the sanitary location and construction of water wells.

Municipalities, through their water departments, often enter into contracts for wells where the specifications are limited and incomplete. Major sanitary phases may be covered, but minor features of sanitary

construction which may seem unimportant and are capable under certain conditions of causing serious pollution, are not included.

On the other hand, it is unsatisfactory and unfair for a municipality to specify rigidly the location, casing and detail construction of a well and then attempt to have the well contractor guarantee the quantity and the sanitary and mineral quality of the water obtained. It is not only unfair to the driller, but unsatisfactory to the municipality. In such instances, the driller must necessarily make his bid sufficiently high to protect himself, for he naturally cannot change the character of the underground formations. His perhaps justifiable high bid not only protects himself on that particular job, but acts as a reimbursement on other similar jobs which have proven unsuccessful under those terms.

Past experience in field inspections, laboratory studies and review of specifications for wells shows the need and use for some standards or minimum sanitary requirements. Court decisions in Illinois and other states leave no doubt as to the legal responsibilities of municipalities and water companies for the safety of public water supplies.

The Division of Sanitary Engineering of the Illinois Department of Public Health has prepared "standards" or specifications for proper well location and construction from the sanitary viewpoint. The specifications are composed of sections designed to be incorporated in general well specifications and include only those features which have an effect upon the sanitary quality of the water.

These specifications have been built up gradually and the ideas embodied therein are not based upon hypothetical possibilities of well pollution, but upon actual field conditions of how wells have been, are being, and can be, polluted.

In the "standards" or specifications shown in the Appendix to this paper there have been included after each item of the specifications the public health reason and the "satisfactory compliance" or the conditions which satisfy the specifications. The specifications were so written as to be of value and use to the engineer, contractor or waterworks official in drawing up and including the essential sanitary features in general well specifications. The public health reason was included to give information of educational value to engineers, municipal and health officials. The "satisfactory compliance" section serves as a guide or "sanitary yardstick" by which waterworks men can "measure" the sanitary features of their present wells and answer the question—"are the wells pollution-proof?"

APPENDIX—SPECIFICATIONS

SECTION I. DRILLED WELLS

A. ROCK WELLS

1. Location

(a) *Surface drainage, flood water: The well shall be so located as not to be subject to surface drainage of flood water.*

Public Health Reason: All surface water is contaminated, the nature of the contamination depending upon the character and amount of objectional impurities with which the water has contact. Flood water often contains sewage.

Satisfactory Compliance: Location should be where ground does not become water logged at certain seasons, where elevation is above maximum high water level of nearby streams and where the surface drainage is away in all directions.

(b) *Cesspools, privies: The well shall be so located as not to be subject to seepage from cesspools, privies, sink-holes or any accumulation of waste.*

Public Health Reason: Seepage from cesspools and privies always contain, and seepage from sink-holes and accumulation of waste may contain, organisms of intestinal origin which are capable of causing water-borne illness.

Satisfactory Compliance: Safe distance from a well to such sources of pollution depend upon the character of the upper strata at the location. A privy or cesspool should always be at least 75 and preferably 100 feet away, with natural surface drainage away from well. In creviced limestone there is no safe distance and proper construction of the well must eliminate the danger.

(c) *Sewers: The well shall be so located as not to be subject to seepage from sewers or tile lines carrying cesspool or septic tank effluent.*

Public Health Reason: Sewers carry animal and human wastes and seepage therefrom contains dangerous organisms.

Satisfactory Compliances: Safe distance from sewer to well depends on the character of the upper strata at the location, but all sewers, tile lines carrying cesspool or septic tank effluent and connections from pumping station toilet to street sewer, should be constructed of cast iron pipe with joints calked water-tight for a distance of at least 50 feet from well. In creviced limestone there is no safe distance. No sewer lines, regardless of construction should pass within 10 feet of well casing.

(d) *Abandoned wells: The well shall not be subject to seepage from abandoned wells.*

Public Health Reason: Abandoned wells open at the top or those with defective casings allow the entrance of surface and shallow ground water which often finds its way to the water-bearing strata of the wells in use.

Satisfactory Compliance: Safe distance between abandoned wells and those in use depends upon the condition of casing and construction of the abandoned wells and the strata they penetrate. Abandoned wells which are located and constructed so that contamination may enter them and reach the well in use, should be filled with concrete, puddled clay, or some other non-porous material or should be plugged at a depth of sealed so as to prevent possible contamination of the water bearing strata. Whenever any well is abandoned, it should be plugged or sealed as described above and should never be used for the disposal of wastes.

2. Construction

(a) *Casing material: The casing shall be of such material that when in place it will be water-tight its entire length.*

Public Health Reason: Defective and leaky casing allow polluted shallow ground water or water of an undesirable quality to enter well.

Satisfactory Compliance: Materials for casings are cast iron, wrought iron and screw-joint steel. Rivited steel or slip joint pipe are generally unsatisfactory as riveted pipe leaks along the seam and slip joints are not always water-tight.

(b) *Length of Upper Casing: The upper casing shall be of a sufficient length to penetrate a solid rock formation and be sealed into this formation so as to exclude any water from above seal entering around and directly under the seal.*

Public Health Reason: Water in ground above such a seal is generally polluted or subject to pollution which can travel down on outside of casing and enter well if casing is not properly scaled into solid rock formation.

Satisfactory Compliance: Suitable formation is that classified as "solid rock" by geologists and into which casing is sufficiently driven or so sealed with grout or a lead or expanding-rubber packer or similar devise so that no water above and around casing can enter well at seal.

(c) *Corrosion of Casing: Casing extending through corrosive strata or water, shall be protected from same.*

Public Health Reason: Corroded casing allows the entrance of water of undesirable mineral and sanitary quality.

Satisfactory Compliance: Prevention of corrosion can generally be accomplished by installing a shell of cement or asphalt grout around casing by leaving at least a 2-inch annular opening between casing couplings and drill hole wall for grout. When replacing a corroded casing, the old casing should either be removed and the drill hole reamed out to proper size for the cement grout shell or install a casing of lighter material inside the corroded one to act as an inner form for the grout. This latter method, of course, reduces the size of well. Corrosion can be reduced in new wells by installing cast iron or genuine wrought iron pipe to which has been applied a double coating of bituminous material.

(d) *Closing casing after drilling: Upon completion of drilling, casing top shall be cut off level and tightly closed until pump is installed.*

Public Health Reason: With casing open accidental or malicious contamination of water bearing strata can result and unless casing is cut off level, proper sanitary method of closing top after installation of pump cannot be accomplished.

Satisfactory Compliance: A cap screwed onto or a wooden plug driven securely into casing is satisfactory. A plank, burlap sack, etc. is unsatisfactory.

3. Pits

No pit shall be left permanently around casing top and casing shall end at least 6 inches above pumping station floor which floor shall be at least 12 inches above ground surface.

Public Health Reason: Pits collect waste material, station floor drainage, oil, etc., which can enter an open casing top ending in a pit.

4. Pump connections

(a) *Deep well pump, air lift: A water-tight connection shall be made between the drop pipe and casing top.*

Public Health Reason: Annular space between casing top and drop pipes allows dirt, oil, waste pumpage to enter well when opening is not closed water-tight.

Satisfactory Compliance: Safe closing of space can be accomplished by devices sold with pump installed or by placing a lead seal between drop pipe and casing top. When well has an outer casing annular space between both casing tops should be closed.

(b) *Pump discharge above base: When discharge is above pump base, the casing or casings, if the well has an outer casing, shall extend as far as possible into the pump base so as to effectively cover the annular space between casing tops and there shall be no hole in pump base so located as to allow any oil or water to enter well.*

Public Health Reason: Pump bases very often act as collectors of oil and waste pumpage which should be drained away from well and prevented from entering around drop pipe.

(c) *Breather or Vent Pipe: Any breather or vent pipe which taps casing or extends through seal or connection at casing top shall end at least 2 feet above station floor, the end pointing downward and finely screened.*

Public Health Reason: Such vent pipes unless properly protected, allow dirt and dust to enter well.

(d) *Sampling Faucet. On the discharge pipe of each well pump shall be an approved tap for the collection of samples.*

Public Health Reason: Regular sanitary analyses are advisable in keeping an analytical check on the qualitty of the water direct from each well.

5. Sterilization

New wells, Repairs: Before either a new well or one having been repaired is placed in use, the well shall be sterilized.

Public Health Reason: Contamination due to the newness of the material, that introduced by workmen during the installation of pump in new well or repairs on old well often persists for long periods of time unless well is sterilized.

Satisfactory Compliance: Sterilization can be accomplished by adding chlorine or a solution of chloride of lime to water in well and allowing it to stand for several hours before pump is put into operation. The water as discharged should show a residual of at least 0.3 p.p.m.

B. DRIFT WELLS

The location, general construction and equipping of drilled drift wells is practically the same as for the rock wells with the following exceptions.

Length of Casing. The casing shall extend to the water-bear- stratum.

Public Health Reason: Shallow ground water above the water-bearing strata is often subject to pollution and should be excluded from well.

Gravel Packed Wells: In wells where gravel is fed between inner and outer casing, such outer casing shall penetrate an impervious stratum sufficiently to prevent water above impervious strata from entering well and the annular space between the drop pipe and both basing tops shall be closed water-tight.

Public Health Reason: Water above the first impervious stratum is generally subject to contamination and unless the outer casing is properly extended into an impervious stratum and closed at the top, shallow ground water or surface contamination can enter the gravel and follow down to the screen and into the well.

Satisfactory Compliance: An impervious stratum such as clay, may sometimes not be encountered and in such cases the outer casing should extend to the water-bearing strata.

Section II. Dug Wells

A. GENERAL

1. Location: Same as for drilled wells.

2. *Wall or curbing material: The walls or curbing shall be of such material that when in place it will be water-tight to the water-bearing strata to be drawn upon and shall in no case extend less than 10 feet below the the ground surface.*

Public Health Reason: Shallow ground water above a depth of 10 feet is generally polluted and should be excluded from well.

Satisfactory Compliance: Material for such walls is concrete made water-tight by adding four to eight pounds of hydrated lime per sack of cement or by other approved water-proofing compound. When concrete pipe is used joints should be made water-tight. Porous concrete, sheet metal, riveted steel and brick are generally unsatisfactory.

3. *Manhole Openings: Manhole openings shall have sides raised at least 3 inches above well top and shall be closed by a cover having overhanging sides.*

Public Health Reason: Manhole openings not adequately protected allow dirt and animal pollution, etc., to be washed into well.

Satisfactory Compliance: Manhole covers can be made from concrete or metal-covered wood. Wooden covers are not satisfactory. Provision should be made to keep covers locked.

4. *Vents for Air Release: Vent Pipes for air release shall be protected from allowing contamination to enter well.*

Public Health Reason: Improperly constructed vents allow dirt, dust, bugs and bird pollution to enter well.

Satisfactory Compliance: Pipes should end in a reverse turn pointing downward with the end at least 12 inches above well top and covered with fine copper screen.

5. *Suction Pipe Openings: Opening for suction pipes shall be so constructed to prevent entrance of dust and dirt, etc.*

Public Health Reason: Suction pipe openings when not properly constructed in well top or side allow an avenue for the entrance of contamination.

Satisfactory Compliance: One method for constructing suction pipe openings is by placing in forms short lengths of pipe larger in diameter than suction pipe when top or side is poured and the annular space between suction pipe and opening be calked water-tight with lead. Suction pipe to be used can also be placed in wall when poured, thus eliminating annular space to be filled.

6. *Pumping Machinery Installation. Pumping Machinery shall not be installed so as to necessitate the entrance of operator into the well.*

Public Health Reason: Persons entering the well track and otherwise cause the entrance of contamination.

Satisfactory Compliance: Pumping machinery should be located outside of the well.

B. WELLS NOT COVERED OR PARTIALLY COVERED BY BUILDING

1. *Walls and Top. Walls or curbing shall extend at least 3 feet above the ground surface at well and shall be covered by a properly draining water-tight concrete top.*

Public Health Reason: All possibilities of surface water, dust, dirt, animal and bird pollution entering well should be eliminated.

2. *Manhole openings, vent pipes and suction pipes,* as previously described above.

C. WELL COVERED BY BUILDING WHOSE FOUNDATION IS CONTINUATION OF WELL WALLS

1. *Walls and Top: Walls of well shall extend at least 1 foot above ground surfaces and shall be covered by a water-tight concrete top.*

Public Health Reason: The water-tight well walls extending above the ground surface protects the well against allowing the infiltration of shallow ground water and eliminates the problem of having to drain a sub-ground pump room.

2. *Manholes, vent pipes* and *suction pipe openings*, should be constructed as described above.

D. WELL COVERED BY BUILDING LARGER IN PLAN THAN WELL

1. *Walls of well shall extend at least one foot above floor of building which floor shall be above ground surface and shall be covered by a watertight concrete top.*

Public Health Reason: Wells inside of buildings are generally subject to dirt tracked or brought in by persons. Well walls, therefore, should extend above the building floor so that such dirt cannot be washed into well.

2. *Manholes, vent pipes, suction pipe openings*, the same as described above.

EVERGLADES DOMESTIC WATER SUPPLY[1]

By Carl F. Warner[2]

The vast area of the Everglades with a rapidly increasing population is confronted with the problem of a sanitary water supply, satisfactory for drinking and domestic purposes. The problem does not so much concern those towns bordering Lake Okeechobee, where an abundant supply of easily processed water is available, but more particularly those settlements of sufficient distance from this great Lake shore, where the laying of pipe lines is an economic impossibility.

For drinking water, rainfall has been a chief source of supply, and bottled water which is shipped in, is quite well patronized.

The uncertainty of an adequate supply of rainfall, and the expense of importing water, has led to more or less extensive means of securing an abundant supply of safe, potable water.

Wells naturally would be looked to for a source of supply. The few wells that have been drilled in this area have proven unsatisfactory. Shallow wells have produced a satisfactory flow, but the water is colored, slightly turbid, very hard and contains hydrogen sulfide. Two analyses of this water are available, and are as follows:

	p.p.m.	*p.p.m.*
Total hardness	657	702
Methyl orange alkalinity	570	600
Phenolphthalein basicity	0	0
Free CO_2	90	130
Odor	H_2S	H_2S
Turbidity	18	1
Color	100	100

A water of this type would be very difficult to render potable.

At the University of Florida Everglades Experiment Station near Belle Glade, a well has been drilled to a depth of 1332 feet. A flow was struck at a 600 foot depth and a very saline water resulted. The 1332 foot flow still produced a salt water.

[1] Presented before the Florida Section meeting, April 2, 1931.

[2] Chemist, Crescent City, Fla.

There remained only one further source of supply. This was the great drainage canals, cut to a width of 60 feet and to bed rock a depth of 8 feet, and connecting Lake Okeechobee with the Atlantic Ocean.

Samples of this water were analyzed. It was found that a treatment method could be employed, which would produce a water both sanitary and satisfactory for domestic purposes. The Canal in question is the Hillsboro. The treatment plant to be discussed derives its source of supply from this Canal, and is situated 18 miles southeast of the point where the Canal meets Lake Okeechobee.

The Hillsboro Canal passes through two towns, has an entirely unrestricted water shed, and there results a water that is contaminated with pathogenic bacteria. Routine analyses by the State Board of Health have shown that this raw water is unsafe for drinking purposes and has always given a positive B. coli count.

The analysis of the Canal water is shown below:

	p.p.m.
Total hardness	309
Methyl orange alkalinity	302
Phenolphthalein alkalinity	0
Turbidity	10
Free CO_2	24
Color	200

It was on the basis of these analyses that the treatment plant was installed. Treatment consisted of the addition of lime and soda ash, followed by sodium aluminate, filtration, chlorination, and a satisfactory water was produced.

It was not long, however, before the realization dawned, that, at the time of the plant installation, the nature of the Canal was not understood. The plant was built around the middle of the winter months, at a time when the alkalinity and color were at a minimum and taste was only slight, due to the lessened bacterial activity in the cool water.

With spring, and rains, the water soon presented a problem. Leachings through the sawgrass peat produced a high color, the water absorbed an excess CO_2 from the decaying fibre, and the Canal which has a porous soft limestone bottom, soon produced a water with a very high alkalinity. It was found that it was practically an impossibility to produce a satisfactory water with the treatment method employed at that time. An alum feeder was installed, but it was

necessary to feed the alum in the softening tank and was dosed to the water only 7 minutes after the addition of the lime and soda ash. The result was that the lime had too little time to complete its reaction before the addition of the alum. A neutralization and a wasted reaction resulted, and the water was delivered little changed from its natural state.

Work was then started on the construction of a plant that would deliver a clear, potable water the year round and thus furnish a solution to the problem.

The treated water by this time, due to the addition of large quantities of lime, was very high in carbonate hardness. Already systematic disorders were prevalent in the negro quarters, where rain water was not available, due it is judged to the excess mineral the water contained.

The problems to contend with were color, alkalinity, taste and purity. Raw waters analyzed over a period of months showed the following results in parts per million.

pH 7.2 fairly constant

Color	*Alkalinity*
500	70
500	600
150	400
150	150 etc.

The alkalinity has risen, following a heavy rain on successive days, 205, 333, 433 p.p.m. This change was recorded following a short period of rainy weather, preceded by a long dry spell. It was necessary then to so design a plant that it would handle any of the aforementioned waters, and one that would have its chemical feeds easily adjusted. Likewise with such sudden changes in the raw water analysis, frequent analyses were necessary.

The water is free from hydrogen sulfide, but does contain a fairly fixed musty-peaty odor and taste, varying from faint to very strong.

In the laboratory the following tests were studied.

AERATION

For taste and odor removal

Taste and odor vary with the seasonal temperatures of the water. The water during normal high temperature periods built up a very disagreeable odor which was easily removed by aeration. The taste

would remain, but could be reduced to a minimum by excessive aeration.

For carbon dioxide removal

Free CO_2 varies from 8 to 70 p.p.m. The maximum could be reduced to 10 with practical aeration. Pre-aeration would then be of an economic benefit as 1 grain per gallon of lime is required to remove every 13 p.p.m. of free CO_2.

SOFTENING

Adequate time for the softening reaction was found necessary before neutralization and color removal, or the color would become fixed and difficult to remove. In cases of high color, it was found satisfactory and frequently necessary to overdose slightly with the lime, and deliver a water with free hydroxide, to produce a satisfactory color removal.

NEUTRALIZATION

When the lime reaction was completed, the softened water contained carbonate. Re-carbonization was considered to restore the carbonate to the more soluble bi-carbonate form. This was found to be unnecessary, when alum was used, as sufficient CO_2 was liberated to produce the bicarbonate, and the water contained sufficient alkalinity to afford a good reaction. A fine pinhead floc resulted and color was very efficiently removed.

It was further found that in the softening reaction, sodium aluminate proved invaluable, if added a few minutes after the lime-soda ash solution. Sodium aluminate for color removal was found to be of no benefit, but used in this way the lime reaction was apparently stepped up, a large floc resulted and settled rapidly.

Other tests conducted were super chlorination, the use of chlorinated copperas, and alum prior to softening. Super chlorination was of no benefit, no floc could be produced by the use of chlorinated copperas, and due to the high alkalinity of the raw water, excessive dosage of alum was necessary to produce a floc.

The decision rested with a treatment with pre-aeration, softening, neutralizing, filtration and chlorination. The plant was modified to meet this treatment method. A neutralizing tank was erected and so connected that the water would flow by gravity from the top of the softening tank.

An open gravity filter replaced the steel drum closed pressure type and was so arranged to take the water by gravity from the neutralizer and deliver it to storage, where the water was chlorinated enroute.

Aeration was accomplished by means of a Coke tray type aerator supplied with water from an automatic pressure pump on the Canal bank. The influent flow was controlled by an automatic value which in turn was controlled by the water depth of the softening tank.

A dry feed machine, designed for small water plants was purchased to be used for the feeding of alum. The machine measures the alum into a solution pot and the alum is delivered to the neutralizer by gravity.

In the operation of small water plants, the elimination of excess labor is imperative. The plant is so installed that the opening of three valves, alum feeder, chlorinator and filter effluent, puts the plant in operation, and it remains so until the valves are closed.

Accurate chemical control is maintained by gauged controls of lime-soda ash, and alum calculated to rate of flow and grains per gallon, and graphically recorded. Daily analyses are taken on the raw water and at stages through its treating process.

Four hours time are allowed for the softening reaction and 2½ hours for the neutralizing.

Bacteriological investigation of a completely processed water, without chlorination, have shown a water free from B. coli. The necessity of a safe guard is realized, however, and a residual 0.2 or more p.p.m. chlorine is maintained at all times.

Analyses necessary for control are readings taken on free CO_2 and end points with phenolphthalein and methyl orange. From these are calculated the p.p.m. of OH, CO_3, HCO_3 and free carbon dioxide.

It is interesting to note that the presence of a phenolphthalein reading on the treated water is always accompanied by an increase in color.

Efforts are made to maintain a water with 0.5 p.p.m. free CO_2 with a pH of 7.5 to 8.0. A marked improvement in the removal of the remaining color is noted by this slight change. This is only possible, however, when the correct dosage of lime has been used. If the treated water has an alkalinity of over 100 p.p.m. then insufficient lime has been added, and a higher color of the treated water results.

Efforts are made to maintain a water with 50 to 60 p.p.m. alkalinity, and a pH between 7.5 and 8.0. A water with such an analysis, has a color range around 10 to 20 p.p.m.

So greatly has the character of the delivered water been improved, that rain water tanks have been discarded and residents are satisfied with the water for every domestic purpose.

There remains one further problem, to which there is already a solution in sight. This is the removal of the residual taste in the water which is not completely removed by the treatment process.

Some efforts at taste and odor removal were carried out last summer, with the use of ammonia, forming chloramine, but the tests were only crudely conducted and a fair trial was not given, although some differences were noted. It is believed, that introducing the ammonia at an earlier stage in the process, instead of a few seconds before, as was done in the tests attempted, before the addition of chlorine, would produce much better results.

Interest in the use of the activated carbons, led to the trial of Hydrodarco, and some very satisfactory results were obtained. Odors and tastes were completely removed as well as the remaining color when treated water was used. When tried in the laboratory, using the raw water, color was reduced from 200 to 0 p.p.m.

It is quite necessary to have some method of taste and odor removal in practice before the coming summer months.

So satisfactory have been the results of the tests with the Hydrodarco filter, that the installation of a final filter unit is now being contemplated.

THE CORRELATION OF THE CELLOBIOSE TEST FOR THE COLON-AEROGENES GROUPS

By Charles F. Poe[1]

Every new test which will aid in the separation and identification of the members of the colon-aerogenes groups of bacteria is received with much interest. One of the most recent tests suggested for the separation of these groups is the cellobiose, or cellose, fermentation test. This was proposed in 1924 by Jones (1) and in 1926 by Jones and Wise (2). They studied a series of cultures and found that all strains of the aerogenes group gave fermentation of cellobiose with gas production, whereas the members of the colon group, with one exception, gave fermentation but no gas production.

Koser (3), in 1926, confirmed this work and found 106 members of the aerogenes group to give acid and gas production, while one strain gave only acid production. Out of 94 colon strains (methyl red positive, Voges-Proskauer negative, citrate negative), he found all except 11 to be negative as far as gas production was concerned. He also found an "intermediate" type of 29 cultures which was methyl red positive, Voges-Proskauer negative, and citrate positive. Of these, all except 5 showed gas production with cellobiose. Koser did not believe these 29 cultures to be true colon strains of fecal origin.

Lewis and Pittman (4), in 1928, studied the correlation of differential tests with the sanitary survey and found the cellobiose and sodium citrate tests to correlate very well with the source. They, however, found a high percentage of the cultures belonging to the colon group to be cellobiose and sodium citrate positive. There were 47.1 percent citrate positive and 65.4 percent cellobiose positive.

Most of the cultures used for the study here reported were isolated from waters collected from fourteen different states and southern Canada. The primary object of this investigation was to study the correlation of the cellobiose test with the methyl red and Voges-Proskauer tests, using cultures obtained from widely different sources.

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The cellobiose broth was made according to the usual directions for sugar broths except that the cellobiose content was reduced to 0.25 percent, because of the expense of this sugar. The tubes of cellobiose broth were then inoculated with cultures of the different organisms. Gas readings were made at the end of 2, 5, 7, and 14 days.

Of the organisms studied, 195 were members of the colon group and 156 of the aerogenes group. There were 32 organisms which gave irregular reactions. Of these, 19 were positive for both the methyl red and Voges-Proskauer reactions and the remainder were negative for both reactions. The organisms are arranged in table 1 according to their cellobiose test. The sodium citrate and uric acid tests are also given for comparison. In all of the tables, the production of gas is considered a positive reaction in cellobiose medium.

TABLE 1

Correlation of tests with the methyl red and Voges-Proskauer reactions

TEST	COLON GROUP		AEROGENES GROUP		IRREGULAR GROUP	
	Positive	Negative	Positive	Negative	Positive	Negative
Cellobiose	44	151	163	1	32	0
Sodium citrate	44	151	163	1	32	0
Uric acid	58	137	155	9	28	4

As will be seen from table 1, the correlation of the cellobiose test for the colon group was not very satisfactory, being 77.4 percent perfect. Although there were the same number of organisms giving positive reactions with both the cellobiose and sodium citrate media, they do not, in all cases, represent the same organisms. The correlation for the aerogenes group, on the other hand, was almost perfect. In each case where there was lack of correlation, the tests were repeated at least five times.

It was thought that some information might be gained by studying the members of the colon group in an arrangement which would show the relationship of the different tests. Such an arrangement is offered in table 2.

There were 102 organisms, or 52.3 percent, which showed a correlation of the methyl red and Voges-Proskauer reactions with all three tests. By selecting the cellobiose and sodium citrate tests, 136 organisms gave negative results for both media—69.7 percent correlation with the methyl red and Voges-Proskauer tests.

It was thought that the organisms of the colon group which fermented cellobiose with gas might belong to the sucrose fermenting section of that group. The 44 organisms of the colon group which gave a positive cellobiose reaction were tested in sucrose medium. The results, as listed in table 3, show poor correlation between the cellobiose and sucrose tests.

The evidence presented indicates that the cellobiose test does not correlate exceedingly well with the methyl red and Voges-Proskauer

TABLE 2

Relationship of tests for the members of the colon group

NUMBER OF ORGANISMS	CELLOBIOSE	SODIUM CITRATE	URIC ACID
102	−	−	−
34	−	−	+
9	−	+	−
6	−	+	+
15	+	+	+
14	+	+	−
3	+	−	+
12	+	−	−

TABLE 3

Correlation of the positive cellobiose colon organisms with the sucrose and sodium citrate tests

NUMBER OF ORGANISMS	CELLOBIOSE	SUCROSE	SODIUM CITRATE
10	+	−	−
5	+	+	−
17	+	+	+
12	+	−	+

tests, but, nevertheless, as well as the sodium citrate and much better than the uric acid test.

Koser (5), Pawan (6), and Lewis and Pittman (4) have studied waters of different sanitary quality, and have shown that those of high sanitary quality have a greater percentage of the members of the colon group which are citrate positive than do polluted waters. They conclude that the citrate test is a better index of fecal pollution than are the methyl red and Voges-Proskauer tests.

In discussing the methyl red and Voges-Proskauer tests, Koser (7) states that some investigators believe these tests to have little or no practical significance in water analysis, and a number of labora-

tories no longer use them. It seems to the writer that the methyl red and Voges-Proskauer tests still serve a useful purpose and should not be discarded even in routine water analysis. The finding of methyl red negative and Voges-Proskauer positive organisms gives a group of organisms which immediately may be considered of non-fecal origin. The correlation of this group with the citrate and cellobiose tests has been found to be almost perfect by various investigators. This leaves the colon group, which Koser divides into the fecal (citrate negative) and the non-fecal (citrate positive) sections. Lewis and Pittman (4) found the cellobiose test to correlate fairly well with the source. According to their results, a like division might be made using the cellobiose test in lieu of the citrate test. Both of these divisions cannot be correct, as these two tests do not entirely correlate for the colon group, as may be seen from table 2. For the colon organisms showing a positive reaction for one or both tests, there was less than a 50 percent correlation.

CONCLUSIONS

1. The cellobiose test does not give a satisfactory correlation with the methyl red and Voges-Proskauer reactions for the colon group.
2. The correlation for the aerogenes group is almost perfect.
3. With the colon organisms, a satisfactory correlation is not shown with the cellobiose, sodium citrate, and uric acid tests.
4. The cellobiose and the sucrose tests do not correlate for the cellobiose positive members of the colon group.

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EFFECTS OF AGE AND STORAGE TEMPERATURES ON GROWTH OF BACTERIA IN WATER SAMPLES

By Gayfree Ellison,[1] H. Waton Hackler[1] and W. Alfred Buice[1]

The "Standard Methods of Water Analysis," Sixth Edition,[2] prescribes that water samples to be analyzed bacteriologically shall be tested at "not more than six hours for impure waters and not more than twelve hours for relatively pure waters" after the taking of the sample. Standard Methods furthermore states, that "During the period of storage, the temperature shall be kept between 6° and 10°C."

Is it necessary that water samples be stored at 6°C. to 10°C. and that they reach the laboratory within six to twelve hours. An examination of the literature on bacteriological water analysis reveals the fact that there is no published comparison of the numbers of bacteria in plate count of duplicate samples kept at room temperature and on ice. Nor is there a comparison of the daily recorded numbers of Bacterium coli in duplicate samples in room temperature and in icebox temperature. It is the purpose of the present investigation to determine if requirements of the storage temperature and of the maximum time limits are really necessary.

METHODS

Two samples, duplicates, of water were taken in sterilized gallon-sized jugs from the Canadian River. Each duplicate sample was tested for agar plate count and for the number of Bacterium coli present immediately on arrival at the laboratory, within an hour after collection of samples. Each of these tests were made in accordance with the requirements of Standard Methods, Sixth Edition. One of the two duplicates was then put in an icebox and the other was

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[2] "Standard Methods of Water Analysis," Sixth Edition (1925), published by American Public Health Association, New York.

kept at room temperature. Each sample was run for plate count and for number of Bacterium coli each day for five days in succession and tabular records were made of results.

Two such duplicate samples were taken from the river each Monday for 10 Mondays in succession during the months of March, April, and May, 1927. Each week's samples were examined in the same manner as were those mentioned above.

Likewise, for 10 Mondays in succession two duplicate samples were taken from a farm-house well. The farm well samples were run concurrently and in the same manner and under the same conditions as were the river water samples.

RESULTS

The results obtained were tabulated and filled some twenty-two pages. Only a summary of results will be given.

The agar plate count. By reference to table 1 it will be seen that the river water samples showed an average plate count of 1,100,000 in the analyses started immediately after taking of samples. The tests run on the five succeeding days showed a general progressive increase in number of bacteria up and including the third tests, run at forty-eight hours. After forty-eight hours there was no material change in number of bacteria. Table 1 shows that by the second day the number of bacteria in the river water and in both storage temperatures had trebled. There were slightly fewer bacteria in the samples kept in the ice box, but the difference was not sufficiently large as to appear of significance.

The farm well water samples averaged 350 total count in the analyses made immediately on taking of samples. In general, the bacteria increased progressively in numbers till there were three to four times the original number. There were somewhat fewer bacteria in the samples kept in the ice box. The progressive increase in number of Bacterium coli continued through a large number of days than in the case of the river water.

From table 1 it appears that icing of samples of water shipped to laboratories is of doubtful advantage for the plate count, even though the ice does not melt in transit. But it does appear from table 1 to be of considerable importance in the plate count that the water analysis be started at some time within twenty-four hours after taking of samples, the exact time as a maximum limit for the plate count not being determined by our tests.

The change in number of bacterium coli present. The number of Bacterium coli present in the several samples of the two waters was

TABLE 1

The average plate count for the 12 samples of each of the two waters at both storage temperatures and for each 24 hours for five days

AGE OF SAMPLE, HOURS	TEMPERATURE	PLATE COUNT AVERAGE	
		River water	Farm well water
0		1,100,000	350
		1,100,000	350
24	Room	1,900,000	450
	Icebox	1,800,000	400
48	Room	3,400,000	1,300
	Icebox	3,100,000	850
72	Room	3,300,000	1,500
	Icebox	2,900,000	950
96	Room	3,600,000	1,300
	Icebox	3,200,000	1,100
120	Room	3,300,000	1,500
	Icebox	3,100,000	1,400

TABLE 2

Percentage of tubes showing changes in number of Bacterium coli per cubic centimeter, both waters, during a period of 5 days

	RIVER WATER		FARM WELL WATER	
	Room temperature	Icebox	Room temperature	Icebox
Bacterium coli average percent of tubes showing:				
Decrease in number	42	34	60	52
Increase in number	8	4	16	12
Unchanged in number	50	62	24	36

estimated in the manner prescribed by Standard Methods, Sixth Edition, p. 104.

Table 2 reveals the fact that only a relatively small percentage of

tubes of both river and farm well waters showed *increases* in the number of Bacterium coli per cubic centimeter of water. This was true for samples kept at both temperatures.

A considerable percentage of the tubes showed *decreases* in number of Bacterium coli per cubic centimeter of water. This means that in an appreciable percentage of cases Bacterium coli might be missed in an analysis made a considerable time after taking of samples; or the colon group might be so reduced in numbers as possibly to mislead the laboratorian in estimating the significance of the presence of those organisms. There were smaller percentages of tubes of icebox samples showing decrease in the number of Bacterium coli than there were of the samples at room temperature. Therefore, it appears that a slight advantage for accuracy in the Bacterium coli estimate is gained when the samples are kept at the lower temperature.

CONCLUSIONS

Icing of water samples is of but slight advantage for accurate plate count and accurate Bacterium coli test. The advantage is so slight that it does not appear that icing is a necessity.

The amount of time elapsing between taking of samples and the running of both plate count and Bacterium coli test appears to be a very much more important factor in favoring or reducing chances of error.

SOCIETY AFFAIRS

THE CANADIAN SECTION

The annual convention of the Canadian Section was held this year at Niagara Falls, Ontario, on March 9, 10 and 11, 1932. This was the 12th annual convention of this section. It was felt that present conditions might keep the attendance at a lower figure than in previous years. The result was, however, quite the contrary and this year's attendance established a new record for all times. The total registration was 316, a gain of 70 over last year. This result is most interesting to the waterworks men of Canada. It should give them encouragement to carry on the work with which they are charged and it should indicate to them and to all municipalities operating waterworks systems that, irrespective of financial conditions or the economies which must be accepted in municipal business, the operation of a waterworks system is one branch of municipal activity which cannot be interfered with. The health of the water consumer and the desire to give the consumer a palatable, safe and economical water supply is of paramount importance.

The convention was held at the General Brock Hotel at Niagara Falls. This was a most excellent location, since a large number of waterworks systems are in operation in that vicinity. In addition to this the Canadian Section was very pleased to have as guests a number of waterworks men from across the border. An invitation had been extended to the members of the American Water Works Association living in the vicinity of Niagara Falls. The Canadian Section was very glad to know that this invitation had been accepted and a number were in attendance.

The papers at this year's convention included a number of important subjects. The opinion of those present at the convention was to the effect that the papers were exceedingly good and that the authors had carried out their work in a most satisfactory and successful manner.

The papers included technical matter and various other phases of waterworks operation. On the first day of the Convention a luncheon was served at which 187 sat down. The delegates were welcomed by

the Mayor of Niagara Falls, Mr. C. F. Swayze, and after the luncheon a description was given by Dr. H. G. Acres of the new Niagara Falls Water Filtration Plant. This plant was also visited on the afternoon of the second day and the various details examined. The plant is a 10 million gallon one and has recently been put into operation. It is so designed that it can be increased to a capacity of 40 million gallons per day.

Following the luncheon the afternoon session included three papers. First on "Waterworks Financing and Accounting" presented by C. D. Brown and A. S. Fitzgerald of Walkerville. This paper gave an excellent description of the various methods of financing water works projects as well as accounting systems which should form a part of the operation of such systems. This paper was followed by one on "Deep Well Water Supplies of Ontario" given by Burn and Edmonds of the Provincial Department of Health. The paper was a most comprehensive one and covered the various deep well supplies which have been developed in the Province. It contained information on the geological formations with particular reference to those which are most favourable as sources of underground water supply. It also indicated the various methods of drilling wells and the characteristics of waters from deep wells with particular reference to chemical constituents.

The final paper on the afternoon was on "Water Hammer and Surge Tanks." This was presented by A. W. McQueen of Niagara Falls. The material contained in this paper was of great interest to waterworks engineers who are responsible for design or operation of systems in which water hammer is a feature to be contended with. All papers were followed with a good deal of discussion.

The second day of the convention was devoted to the business meeting, a symposium on "Taste and Odor Control of Water Supplies" and an inspection of the Niagara Falls Filtration Plant and the Queenston-Chippawa power development of the Hydro-Electric Power Commission of Ontario. In the business meeting new officers elected were as follows: Chairman: W. E. MacDonald, Water Works Engineer, Ottawa, Ontario; New Trustees (for a period of three years): A. M. Bowman, Elmira, Ontario, and W. L. McFaul, Hamilton, Ontario. Other members of the executive are as follows: Past Chairman: N. J. Howard, Toronto, Ontario; Representative on the Governing Board of the American Water Works Association: A. U. Sanderson, Toronto; Trustees: J. G. Archibald, Woodstock, Ontario;

Theo. Lanctot, Hull, Quebec; J. Clark Keith, Windsor, Ontario; R. H. Martindale, Sudbury, Ontario, together with the two new trustees previously mentioned.

The vote of the delegates present indicated Ottawa as the choice for next year's convention. Some discussion took place as to whether it would be advisable to hold the convention at some other date rather than in March. It was left to the executive to settle this matter.

The symposium on Taste and Odor Control in Water Supplies was of particular interest to public health officials and to those responsible for the treatment of water supplies throughout the Dominion. In view of the amount of work which has been done in the province of Ontario in recent months on taste and odor control this symposium proved to be a most timely one. The discussion was introduced by Mr. Delaporte of the Provincial Department of Health. His paper was followed by papers from Mr. Nicklin of Guelph, Mr. Thomas, of New Toronto, Dr. Mustard of Chatham, Mr. Caughey of Wallaceburg and Mr. Matheson of the Provincial Department of Health. These speakers described the various methods which have been tried in their respective centres. They included preammoniation, aeration, activated carbon, as well as other methods tried on a laboratory scale. The symposium will undoubtedly give a valuable impetus to other work in the control of tastes in domestic water supplies.

The final day of the convention found four interesting papers on the agenda. Mr. Keith of Windsor read a paper on "The Winter Operation of Water Works Systems." In this he described the various measures which might be adopted to protect water works systems in cold climates. This included filter plant operation, protection of mains, elevated tanks and other features common to water works systems. Mr. Ferguson, Chief Engineer, of the Federal Department of Pensions and National Health, delivered a paper on "Sewage Disposal and its Relationship to Water Supplies." This was a somewhat new departure from the papers generally presented at the Convention and introduced the subject of measures to be adopted for the control of stream pollution and its relationship to protection of water supplies. Mr. Gore of Toronto concluded the morning program with a most interesting paper on "Modern Water Works Pumping Stations." Recent developments in this subject were described in the paper and illustrated by lantern slides. This

paper was particularly timely in view of the number of pumping stations which have been constructed in Ontario in recent years. The afternoon session was devoted to a paper on "Operating Economies in Water Works Systems" by the new Chairman, Mr. MacDonald of Ottawa. This paper outlines the various procedures which might be adopted to effect economies and increased efficiency in the operation of water works systems. This was followed by a round table conference on various problems with which a superintendent and operator is faced.

In addition to the program of papers and sight-seeing tour the usual program of entertainment was well taken care of. A banquet was held on the evening of the second day and this was followed by an address by the President of the American Water Works Association, Mr. Ross L. Dobbin, of Peterboro, Ontario. An excellent entertainment followed the banquet, making the convention a most enjoyable as well as profitable gathering.

A. E. BERRY,
Secretary-Treasurer.

THE MONTANA SECTION

The Seventh Annual Convention of the Montana Section, was held in Livingston on April 1 and 2, 1932. There were 65 registered for the meetings and 83 attended the banquet on Saturday evening.

The high light of the convention was the presence of Mr. George W. Pracy, Superintendent of the San Francisco Water Department, and nominee for president of the parent association. His attendance and frequent speaking added very materially to the success of the occasion.

What was anticipated as a severe set back to the convention was the auto accident on the eve of meeting, in which our host, Mr. J. R. Cortese, was severely injured. However, due to his tremendous energy in making arrangements to the last minute detail, the affair proceeded with unusual smoothness. "Jim" Cortese has the full backing of his own department, the Livingston Chamber of Commerce, the local press and the individual business men in Livingston. The latest word from him is that recovery may be expected in about two weeks.

Mr. H. M. Johnson, Chairman, presided with his characteristic energy and kept the sessions lively. The principal topics for papers and discussions were:

"The 51st Annual Convention held at Pittsburgh in 1931," a report by Wade Plummer, Superintendent of the Butte Water Company.

"The Design and Operation of the Water and Sewage Treatment Plants for Boulder City," by Earl W. Kelly of the Dorr Company.

"The Livingston Water System and Filtration Plant," by J. R. Cortese, Superintendent, (Read).

"Gas as a Utility," by William H. Barton, Manager, Gas Division, Montana Power Company.

"Round Table Discussions," led by Jos. M. Schmit of Lewistown.

"The Use of Ammonia in the Treatment of Water," by J. W. Forbes of the Montana State Board of Health staff (in the absence of Mr. Brandis of Chinook).

"Covering the City Reservoir at Columbus," by I. E. McClure, Superintendent, Columbus Water Department.

"Advantages and Disadvantages of Company Ownership of Connections from Water Mains to Property Lines," by W. S. Vrooman, Manager, Commonwealth Public Service Company, Deer Lodge.

Discussions of these various papers, and at the Saturday morning Round Table in charge of J. M. Schmit, City Engineer, Lewistown, showed the keen interest taken by the delegates and visitors assembled.

Dr. Cogswell, Secretary of the State Board of Health, attended. He urged the Livingston City Water Commission (all members also present) to equip their very fine filtration plant in that city with a full laboratory as a fitting testimonial to the efficiency and hard work of Mr. Cortese, the Superintendent. He also urged the establishment of local laboratories in all water works plants especially where filtration is practiced in the state.

Prof. W. M. Cobleigh, Dean of Engineering, at the State College, Bozeman, lent his support and spoke on behalf of the School for Water Works Operators, which he conducted, in coöperation with the State Board of Health, two days previous to the annual convention.

Through the courtesy of Mr. A. D. Mars of the Rocky Mountain Section, three Wyoming water works men were in attendance, and Mr. Johnson of the Minnesota Section brought Mr. A. L. Bavone, Secretary of the North Dakota Water and Sewage Conference.

The association went on record as favoring the sewer rental method of raising revenue to defray expenses of operating sewage treatment plants. It also favors legislation for the purpose of placing the water departments of all cities of the first class and authorizing all others

to place by ordinance the water departments under Civil Service regulations.

Among other things, the Section authorized the incoming chairman to appoint a committee to study the part it may play in the work of fostering water conservation and utilization as outlined by Mr. James, State Engineer.

Mr. Wm. Brooks, State Fire Marshal, reported that practically all fire hose, nozzles and hydrant connections in Montana were now of standard size and thanked the members of the organization for their assistance in the detailed work involved in making the necessary changes.

Passing suitable resolutions, the Section adjourned after selecting Havre for the 1933 (8th) Convention (date to be fixed later) and electing Wade Plummer, Superintendent, Butte Water Department, Chairman; Fred Quinnell, Superintendent, Roundup Water Department, Vice-Chairman; E. Sandquist, City Engineer, Havre and J. R. Cortese, Superintendent, Water Department, Livingston, as trustees; H. B. Foote, State Sanitary Engineer, Helena, was reappointed Secretary-Treasurer.

H. B. FOOTE,
Secretary-Treasurer

ABSTRACTS OF WATER WORKS LITERATURE[1]

FRANK HANNAN

Key: American Journal of Public Health, 12: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Modern Boiler Developments and Feed-Water Treatment. W. S. COATES. J. Soc. Chem. Ind., 49: 206–8T, 213–4T, 221–2T, 230–2T, 241–4T, 1930. From Chem. Abst., 24: 5904, November 20, 1930. Full review of modern methods of boiler water treatment. Boiler-feed water is considered as very dilute solution of electrolytes which exist mainly in ionic form. Theory of water softening is discussed.—*R. E. Thompson.*

Use of Barium Aluminate in Feed Water Treatment. R. STUMPER. Wärme, 53: 33–9, 55–7, 1930; Wasser u. Abwasser 27: 116–7; cf. C. A., 24: 1687. From Chem. Abst., 24: 5904, November 20, 1930.—*R. E. Thompson.*

Barium Aluminate, a New Softener for Boiler Feed Water. HEINRICH GÜNTHER. Feuerungstech., 18: 138–9, 1930. From Chem. Abst., 24: 5904, November 20, 1930. This product, made by melting together heavy spar, bauxite, and coal, removes carbonates, sulfates, lime and magnesia.—*R. E. Thompson.*

Processes for the Removal of Gases from Feed Water. KARL HOFER. Die Wärme, 53: 752–6. 1930. From Chem. Abst., 24: 5904, November 20, 1930. Discussion of methods and apparatus. Cuts of apparatus and installations are shown, together with diagrams of processes.—*R. E. Thompson.*

The Action of Carbon Dioxide, Hydrogen Sulfide, Methane and the Absence of Oxygen on Water Organisms. I. NIKITINSKII and Fr. K. MUDREZOVA-WYSS. Zentr. Bakt. Parasitenk., I. Abt., 81: 167–98, 1930. From Chem. Abst., 24: 5788, November 20, 1930. In general, saprophytic properties of given organism are related to its resistance to carbon dioxide and hydrogen sulfide. Both exert narcotic action which is first inhibitory and then lethal. Methane and hydrogen are non-toxic. Many water organisms survive complete absence of oxygen for 10–30 days, or even longer. Resistance to carbon dioxide, hydrogen sulfide, and lack of oxygen decreases with complexity of

[1] Vacancies on the abstracting staff occur from time to time. Members desirous of coöperating in this work are earnestly requested to communicate with the chief abstractor, Frank Hannan, 285 Willow Avenue, Toronto 8. Ontario, Canada.

organism, protozoa being more resistant than rotifers, and latter more resistant than crustacea.—*R. E. Thompson.*

Concerning the Physiology of the Nutrition and Forms of Draparnaldia Glomerata Agardh. V. I. USPENSKAYA. Z. Botan. **22**: 337–03, 1930. From Chem. Abst., **24**: 5791, November 20, 1930. *Draparnaldia glomerata* produces typical tufts as long as carbon dioxide content of water prevents development of pH higher than 8 to 8.2. At pH value much above 8.0, formation of microzoöspores takes place and tufts disappear. If pH value sinks below 7.3, or especially below 7.0, there is formation of zoöspores and absence of well-developed tufts. Characteristic tufts are usually especially well developed when water has pH of 7.3–7.6. In central Russia, when in warm summer weather the pH value of the water of certain streams rises above 8.0, *Draparnaldia* disappears. Similar effect is produced in standing water where the pH often becomes less than 7.0 during the night. Lack of iron also causes *Draparnaldia* to disappear from otherwise favorable habitats. Optimum quantity is stated to be 1.5 p.p.m., as ferric oxide. Effects of temperature, light, and various nutrient solutions on the form of this plant are also discussed.—*R. E. Thompson.*

Judging the Quality of River Water on the Basis of Permanganate Consumption and Chlorine Number. A. BEHRE, H. CHRISTLIEB and MARTHA KONGEHL. Z. Untersuch. Lebensm., **59**: 398–402, 1930. From Chem. Abst. **24**: 5900, November 20, 1930. Data are tabulated showing chlorine numbers and potassium permaganate consumption of several river waters. There is a close correlation between these two determinations and together they are good indicators of the quality of surface waters.—*R. E. Thompson.*

A New Property of Potable Water: Bacteria-Activating Power. G. DENES. Zentr. ges. Hyg. Grenzg., **21**: 111–3, 1929; Wasser u. Abwasser, **27**: 100. From Chem. Abst., **24**: 5901, November 20, 1930. This preliminary contribution points out that there is in some filtered (bacteria-free) waters a bacteria-activating principle which enhances and greatly increases growth of *B. coli* and similar organisms. This principle is exact opposite of lytic principle of D'HERELLE's bacteriophage.—*R. E. Thompson.*

German Laws Relating to Construction and Operation of Water Supply Systems. G. v. MEYEREN. Gas u. Wasserfach, **73**: 842–7, 867–71, 886–90, 923–6, 1930. From Chem. Abst., **24**: 5901, November 20, 1930. Review of laws in various German states.—*R. E. Thompson.*

Water. GEO. G. SCHAUT. Catalyst, **15**: 8, 4–6, 1930. From Chem. Abst., **24**: 5901, November 20, 1930. Average sanitary chemical analysis of water supplied to city of Philadelphia is, respectively, in parts per million, according to its source, the Delaware, or the Schuylkill: total nitrogen (organic and ammonia) 0.13, 0.10; nitrate nitrogen 0.80, 1.25; nitrite nitrogen nil; suspended matter nil; total solids 80 (loss on ignition 28 per cent), 180 (loss on ignition 21 per cent); oxygen consumed 1.5, 1.0; chlorides 4.0, 8.0; iron 0.10, 0.10; sulfates

(SO_3) 20, 60; alkalinity 30, 40; total hardness by soap 50, 100; calcium (as CaO) 16, 32; magnesium (as MgO) 8, 16; free carbon dioxide 6, 6; dissolved oxygen 6.5 (60 per cent saturation), 8.1 (80 per cent saturation); color 3, 2; turbidity nil; pH 7.0, 7.1. Both supplies contain trace of sediment and are negative for taste and odor (both cold and hot). Bacteriological examinations show total count of less than 10 per cc., both on agar at 37° for 24 hours and on gelatin at 20° for 48 hours, and less than 1 colon group organism per 100 cc.—*R. E. Thompson.*

Coagulation Factors in Water Clarification. F. E. DIVINE. Paper Trade J., **91**: 11, 71-2, 1930; Paper Mill, **53**: 38. 16-7, 21, 1930. From Chem. Abst., **24**: 5901. November 20, 1930. Description of experiments carried out to determine cause of, and to find remedy for, irregularities experienced in coagulation of mill water supply with alum. Results showed that mixing of water and alum solution must be performed slowly in order to avoid breaking up floc after it has once been formed.—*R. E. Thompson.*

Modern Water Treatment. H. KLUT. Deut. allgem. Z., **1929**: 266, June 11; Wasser u. Abwasser, **27**: 116; cf. C. A., **23**: 3285. From Chem. Abst., **24**: 5901, November 20, 1930. General.—*R. E. Thompson.*

Observations on the Priming of Saline Waters. J. S. HANCOCK. J. Soc. Chem. Ind., **49**: 369-74T, 1930; cf. C A., **23**: 4516; and HALL, C. A., **23**: 3287. From Chem. Abst., **24**: 5903, November 20, 1930. A continuation (cf. C. A., **21**: 3243). Confirming some of these results it was found that concentration of suspended solids does not increase priming at operating pressures of 150–160 pounds. It is shown that priming of boilers by alkaline water with low total solids is due to organic matter in solution. Determination of such material was made by use of standardized hot potassium permanganate solution. With Nile River water, priming occurred with 2,000 p.p.m. dissolved solids, while with well water, concentration could be carried to from 4000 to 6000 p.p.m. River water with 1000 p.p.m. total solids, of which 25 p.p.m. was organic matter, caused priming. Removal of organic matter with charcoal reduced priming to zero. Formation of bubbles was observed by means of sight glasses in boilers. A description of this phenomena as observed with distilled water, water high in inorganic salts, and water containing organic matter is given. It is believed that concentration of saline solution gives rapid increase in number, thickness, and size of bubbles on water surface. This increases concentration of minute particles of water at surface for dispersion and ejection with steam. This study also confirms theory previously advanced that castor oil prevents priming due to absence of saponification. Experiments made in this connection with saponifiable oils gave increase in priming. Frequent blowing down is suggested for control of priming, keeping concentration of solids in boiler at minimum. Study was conducted with experimental laboratory boiler, with moderately sized stationary boiler, and with locomotive in service.—*R. E. Thompson.*

Analysis of Water Containing Arsenic, Molybdenum, and Bismuth; Colorimetric Determination of Small Quantities of Molybdenum. OSKAR STEINER.

Z. anal. Chem., **81**: 389–91, 1930. From Chem. Abst., **24**: 5903, November 20, 1930. Methods employed and results obtained in analysis of water containing 9.6 p.p.m. arsenic trioxide, 0.8 p.p.m. molybdenum, and traces of bismuth are given. Molybdenum was determined colorimetrically by reaction with tannic acid.—*R. E. Thompson.*

Silica in Spas. PATRICK HEFFERNAN. Arch. med. Hydrology, **7**: 208–10; Chem. Zentr., **1929**: II, 1641. From Chem. Abst., **24**: 5903, November 20, 1930. Occurrence of silica in inorganic and organic worlds and its chemical properties are discussed. Table is given of silica-containing springs. From fact that "silicic acid" does not give true solution, it is concluded that silica in silicon-containing waters is present in colloidal state, and formula $SiO_2 \cdot xH_2O$ is proposed instead of customary formula for silicic acid. Silica-containing spring water, whose action on skin and respiratory tract is especially well known, has antitoxic properties, as was shown by experiments of BILLARD, SAMENTO, KOPACZEWSKI, and others. Author believes that the hydrosol, which has the capability of selective adsorption, is responsible for this action, and attaches no significance to silicate ion itself.—*R. E. Thompson.*

A Field Method for the Estimation of the Salinity of the Water in Mosquito Breeding Places. J. A. SINTON and N. D. KEHAR. Indian J. Med. Research, **18**: 199–201, 1930. From Chem. Abst., **24**: 5906, November 20, 1930. Description of simple titration of chlorides with specially-calibrated pipet, two standard solutions of silver nitrate equivalent in concentration to 2 and 10 milligrams chloride per cc., and saturated solution of potassium chromate as indicator.—*R. E. Thompson.*

Sterilizing Water. JOSEF MUCHKA. Fr. 685,888, December 2, 1929. From Chem. Abst., **24**: 5907, November 20, 1930. In the sterilization of water by means of chlorine or substances liberating it, an excess of chlorine is used which by its depolarizing action generates electrical or electromotive forces; these forces serve to regulate the concentration of chlorine or to maintain the content of free chlorine constant in spite of the varying amount of organic substances present, or to control the flow of water. Excess chlorine is removed afterward by charcoal.—*R. E. Thompson.*

Apparatus for Supplying Gases Such as Chlorine for Treating Water, etc. CHARLES F. WALLACE (to Wallace & Tiernan, Inc.). U. S. 1,777,986–7, October 7. From Chem. Abst., **24**: 5907, November 20, 1930. Various structural details are described.—*R. E. Thompson.*

Aluminum Sulfate. G. KULLERUD and A. D. HØRLÜCK. Dansk Tids. Farm. **4**: 157–71, 1930. From Chem. Abst., **24**: 5941, November 20, 1930. Aluminum sulfate commonly found on market contains 18 molecules of water of crystallization, although literature lists compounds containing 6, 10, 16, and 27 molecules. Basic aluminum sulfate is also known. By repeated recrystallization, pure aluminum sulfate with 18 molecules of water of crystallization was obtained which had pH value of 2.76 (specific gravity of solution = 1.10).

Table is given showing relation between concentration and specific gravity. Instead of analyzing for free acid with sodium thiosulfate solution, specific gravity of solution of known concentration should be determined. Aluminum and sulfate should also be determined.—*R. E. Thompson.*

Sulfate of Alumina. C. D. McCollister. Paper Mill, 53: 41, 20–1, 1930. From Chem. Abst., 24: 5942, November 20, 1930. Brief outline of manufacture and uses.—*R. E. Thompson.*

Decomposition of Hypochlorite Bleaching Solutions. J. Auerbach. Z. ges. Textil-Ind., 32: 376–8, 1929. From Chem. Abst., 24: 5943, November 20, 1930. Experimental data on decomposition of hypochlorite solutions under various conditions are presented.—*R. E. Thompson.*

The Present-Day Status of the "Chloramine" Problem. M. Münch. Z. ges. Textil-Ind., 32: 372–6, 1929. From Chem. Abst., 24: 5945, November 20, 1930. Chemistry and applications of chloramine are discussed.—*R. E. Thompson.*

New Forms and Simple Apparatus for Determining the Water Permeability of Concrete. Ernest Rissel. Zement, 19: 532–5, 1930. From Chem. Abst., 24: 5963, November 20, 1930. Thick disks of mortar or concrete are clamped in metal frame which admits water to upper surface under desired pressure. In this study pressure was kept constant at 13 meters. Apparatus permits 5 specimens to be tested at once. Advantage claimed is that more accurate determination can be made of cross section through which water penetrates.—*R. E. Thompson.*

The Thermal Conductivity of Boiler Scale. Chr. Eberle. Arch. Wärmewirt., 10: 334–6, 1929. From Chem. Abst., 24: 5967, November 20, 1930. Analyses of 17 samples of boiler scale which caused tube damage are given, together with details of typical cases. Gravitation does not affect scale formation, which is controlled by heat transfer rate. Silicate scales are most porous and have lowest conductivity, causing damage in one case when only 0.5 millimeter thick. Lack of water is probably seldom the cause of tube failure.—*R. E. Thompson.*

Pigments for Rust-Preventive Paints. J. Scheiber. Farbe u. Lack, 1930: 427–9, 439–41, 453, 465–6. From Chem. Abst., 24: 6037, November 20, 1930. Function of rust-preventive film is to exclude conditions favorable to rust formation. Desirable properties in rust-preventive pigments are: (1) ability to render iron passive, (2) basic reaction, and (3) "leafing" action. Degrees to which a number of pigments possess these properties are discussed. Extremely basic pigments, e.g., red lead, should not be used with dense oils such as tung oil, as resulting film may be too hard and brittle. Red lead in linseed oil is probably best pigment to use in priming coat. Micaceous iron oxide, because of its mild basicity and its leafing action, is best pigment to use in outer coats.—*R. E. Thompson.*

The Passivifying Action of Minium. E. MAASS and E. LIEBREICH. Korrosion Metallschutz, **6**: 178–81, 1930. From Chem. Abst., **24**: 6037, November 20, 1930. "Passivity" due to use of minium is explained by its alkaline reaction and its possible formation of lead soaps on metal surface.—*R. E. Thompson.*

Permeability of Antirust Pigments. A. VILLA. Recherches inventions, **11**: 82–5, 1930. From Chem. Abst., **24**: 6037, November 20, 1930. Usual tests are not satisfactory for determination of paint film permeability. Author describes use of solution which attacks covered metals very quickly when film presents any openings. Tests are made on aluminum plates, which are painted with material under test, dried, and covered with magnesium chloride solution. Details of tests and results on 32 samples included.—*R. E. Thompson.*

Calcium Compounds in Laundered Fabrics. A. JACKMAN and E. HOWELL. Chemistry and Industry, **49**: 787–8, 1930. From Chem. Abst., **24**: 6024, November 20, 1930. Softening action of sodium silicate on hard water depends mainly on sodium hydroxide formed by hydrolysis. In order to determine composition of deposit formed on fabrics washed in mixtures of soap and sodium silicate with hard water, pieces of calico were boiled 10 minutes in detergent solution, rinsed, and ironed, process being repeated 20 times with fresh solution each time. Four detergent solutions were used: (1) 0.1 percent soap and 0.025 percent silicate in distilled water, rinsing in distilled water; (2) same, except that hard water was used; (3) 0.4 percent soap and 0.1 percent silicate in distilled water, rinsing in same; (4) 0.4 percent soap and 0.1 percent silicate in hard water, rinsing in same. Fabrics treated with distilled water contained practically no ash, (2) yielded 3.4 percent fatty acid and 2.45 percent ash, (4) yielded 2.56 percent fatty acid and 0.94 percent ash. Compositions of ashes were similar, 72.7 to 76.0 percent calcium oxide and 3.8 to 4.2 percent magnesia. Proportion of calcium to magnesium is same as that in which they occurred in the hard water. From calculation of equivalents of bases and of silica and of fatty acids, it is evident that formation of considerable proportion of calcium carbonate takes place.—*R. E. Thompson.*

Determination of Potassium in Very Dilute Solutions and in Soil Extracts. MARGARETHE V. WRANGEL (Princess ANDRONIKOW). Z. anal. Chem., **82**: 224–6, 1930. From Chem. Abst., **25**: 50, January 10, 1931. Detailed directions given for precipitating potassium as $K_2NaCo(NO_2)_6$ and determining nitrite content of centrifuged precipitate colorimetrically with solution prepared from indole and sulfuric acid.—*R. E. Thompson.*

The Settling of Fine Coal in Water with Specific Reference to the Clarification of Washery Water. L. W. NEEDHAM. Trans. Inst. Mining Eng., **79**: 498–520, 1929–30. From Chem. Abst., **24**: 5972, November 20, 1930. Work carried out at University of Birmingham (England) is summarized as follows: useful data regarding ultimate velocity of coal and dirt particles less than $\frac{1}{10}$ inch in size have been obtained, and value of reagents, when used in small quantity, id coagulating colloidal refuse and promoting settling of fine coal particles has been demonstrated.—*R. E. Thompson.*

Dangers to Mains (Gas) and Their Avoidance. JAENICKE. Gas- u. Wasserfach, 73: 858–60, 1930. From Chem. Abst., 24: 5980, November 20, 1930. Dangers in laying gas and water mains in same trench are reviewed. Corrosion and corrosion-resisting coatings are briefly discussed and bibliography is given of German references with respect to protection of mains against earth currents and against soil action.—*R. E. Thompson.*

Deterioration of Nets in Lake Erie. A. G. ROBERTSON and W. H. WRIGHT. U. S. Bureau Fisheries, Document 1083, 149–76, 1930. From Chem. Abst., 24: 6025, November 20, 1930. Bacterial attack is prime cause of net deterioration. Red slime and similar material do not influence greatly strength of the web, except that they harbor destructive bacteria which attack cotton fibers. Preservative treatment for prolonging life of nets is described.—*R. E. Thompson.*

Regeneration of Activated Carbons. A. S. SIPYAGIN and E. S. SERKIN. Zhur. Sakharnoi Prom., 4: 176–81, 1930. From Chem. Abst., 24: 6052, November 20, 1930. Activated carbon made in Russia can be regenerated to 99.2 percent of its original decolorizing power if following process is used: boil 2 hours in 2 percent sodium hydroxide solution, filter, wash with hot water, boil in 2 percent hydrochloric acid, filter, and wash to pH 7.0–7.2. After drying, heat the carbon in retort for 10 minutes at 600–650°. This method gave good results in laboratory and in sugar refinery on large scale. Tables and plans are included.—*R. E. Thompson.*

Corrosion of Lead in Buildings. F. L. BRADY. Dept. Sci. Ind. Research, Building Research, Tech. Paper 8: 30 pp., 1929. From Chem. Abst., 24: 2096, May 10, 1930. Series of tests on corrosion of lead in contact with cement led to following conclusions. (1) Lead in presence of oxygen and aqueous solution of calcium hydroxide is oxidized to lead oxide. (2) Calcium hydroxide solutions remove protective films formed on lead in air. When lead is placed in contact with calcium hydroxide or portland cement mortar under conditions such that infiltration of water takes place, conversion to lead oxide occurs continuously. The water which enters mortar may contain dissolved oxygen and carbon dioxide; but latter, which would form protective film on lead, combines with mortar constituents and lead is therefore subjected to simultaneous action of moisture, oxygen, and calcium hydroxide. Action ceases when calcium hydroxide or mortar becomes carbonated. (3) Aluminous cement is much less corrosive than ordinary portland cement. With respect to corrosion caused by timber, following conclusions were reached. (1) Rapid corrosion of lead may be caused by contact with oak and other woods, due to action of acids in timber in conjunction with moisture and atmospheric oxygen and carbon dioxide. (2) Soft woods cause less corrosion of lead than oak, but action is appreciable. (3) Well-seasoned wood should be employed and precautions taken to prevent ingress of moisture. In soils, corrosion of lead is caused by humic acids and low pH. In general, soils high in organic content are corrosive to lead. Lead is also appreciably corroded in soils containing soluble constituents of ashes or cinders. For prevention of soil corro-

sion the use of chalk or well-carbonated lime as packing, bituminous coatings, and resistant lead alloys are recommended.—*R. E. Thompson.*

The Prevention of Corrosion of Lead in Buildings. F. L. BRADY. Dept. Sci. Ind. Research, Building Research, Bull. **6**: 4 pp., 1929. From Chem. Abst., **24**: 2096, May 10, 1930. A lead damp course was severely corroded after being imbedded in portland cement. Corrosion was attributed to oxygen, water, and calcium hydroxide. Water and oxygen caused the corrosion, while calcium hydroxide prevented formation of basic carbonate by absorbing carbon dioxide from air. Bitumens and bitumen-impregnated felt are recommended for prevention of corrosion. Timber, when wet, corrodes lead because of oxidation in presence of organic acids generated from wood. Dry timber causes no corrosion. Corrosion of lead in soil varies with soil composition. Packing with carbonated lime is recommended in corrosive soils. Bituminous coatings are also recommended.—*R. E. Thompson.*

Practical Results Regarding the Protection of Boiler Parts by Means of "Alumet" Coatings. C. COMMENTZ. Korrosion u. Metallschutz, **5**: 248–9, 1929. From Chem. Abst., **24**: 2096. May 10, 1930. Coatings prepared by spraying aluminum on iron, painting with coating impervious to air (which fluxes the oxides), and heating in absence of air to permit alloying of iron and aluminum, were tested. Locomotive boiler grates treated in this manner were exceptionally resistant to deterioration, giving approximately 5 times the ordinary service. Iron so coated is particularly adapted to grates upon which clinkering coal is used, for superheater pipes, boiler tubes, and flues.—*R. E. Thompson.*

Testing and Evaluating the Life of Coatings. HANS WOLFF. Farben-Ztg., **35**: 182–5, 1929. From Chem. Abst., **24**: 2313, May 10, 1930. While iron rust, when formed, is usually found on surface of metal, WOLFF has observed it on exterior surface of a coating otherwise intact. Apparently iron salts migrated to surface of coating before being converted to oxide.—*R. E. Thompson.*

Water in the Brewing Industry. MARC VAN LAER. Bull. assoc. élèves inst. sup. fermentations Gand, **31**: 35–43, 1930. From Chem. Abst., **24**: 2232, May 10, 1930. Discussion of influence of natural waters on diastatic processes and their function in extraction phenomena, particularly during hopping.—*R. E. Thompson.*

Investigation on Endemic Goiter in Sweden. J. A. HÖJER. Z. Hyg. Infektionskrankh., **110**: 239–55, 1929. From Chem. Abst., **24**: 2173, May 10, 1930. Large milk consumption and low vegatable consumption were established as influencing goiter. No connection was observed between iodine content of drinking water and goiter frequency.—*R. E. Thompson.*

Iodine in the Air, Dew, Soil, and Water in Salta. P. MAZZOCCO. Semaña méd. (Buenos Aires) **37**: 358–64, 1930. From Chem. Abst., **24**: 2177, May 10, 1930. Investigation was conducted with reference to iodine and goiter in

Argentine province, Salta. Iodine was determined colorimetrically by dissolving in carbon tetrachloride. Iodine content of water in Salta varied from 0.4 to 2.5 parts per billion and in province of Buenos Aires from 2.2 to 32 parts per billion. **Iodine in Food in Salta.** P. MAZZOCCO. Ibid., 364–6. **The Iodine Metabolism and Prophylaxis of Goiter in Salta.** P. MAZZOCCO. Ibid., 370–3. Average daily intake of iodine per person is below 0.04 milligram.—*R. E. Thompson.*

Iodine and Exophthalmic Goiter. A. SPRINGBORN and A. GOTTSCHALK. Deut. Arch. klin. Med., **161**: 338–52, 1928. From Chem. Abst., **24**: 2182, May 10, 1930. Effect of administration of iodine in simple and exophthalmic goiter is described.—*R. E. Thompson.*

A Goiter Survey in Albino Rats. ROBERT MCCARRISON. Brit. Med. J., 1930: 3621, 989–92. From Chem. Abst., **24**: 4331, September 10, 1930. Study was made of postmortem records of 2561 albino rats of Pasteur Institute, Coonoor, India. About 5.5 percent of the rats had goiters. Goiter did not develop on complete diets, but did develop on vitamin-deficient diets. Administration of iodine to deficiently fed rats was definitely favorable to goiter formation. On complete diets iodine had no effect—*R. E. Thompson.*

The Influence of Oxygen on the Volatilization of Iodine. PIERRE DANGEARD. Compt. rend., 190: 131–3, 1930. From Chem. Abst., **24**: 2160, May 10, 1930. Liberation of free iodine by marine algae is probably preceded by an oxidative reaction, as it takes place only when oxygen is available.—*R. E. Thompson.*

Acid Fermentation by B. Coli. V. CIANCI. Boll. soc. ital. biol. sper., **4**: 1140–3, 1929. From Chem. Abst., **24**: 2158, May 10, 1930. *B. coli* was grown in NAEGELI's medium containing 1 percent glucose. Acidity, pH, and glucose content were determined at 24-hour intervals for period of 9 days. There was definite relationship between acidity developed, lowering of pH, and decrease in glucose. Inhibition of growth by acid corresponded to minimum pH attained and was reached after 72 hours. After this period there was further slight reduction in glucose, showing that death of bacterial cells was gradual. The pH and acidity remained constant, probably as result of loss of volatile acids. Similar study was made with medium containing only 0.1 percent glucose. The 72-hour cultures reached an acidity less, and pH greater, than did 1 percent glucose medium, a range well above inhibition zone; yet there were no further changes in medium on prolonged incubation.—*R. E. Thompson.*

Saline Drinking Water. V. G. HELLER and C. H. LARWOOD. Science, **71**: 223–4, 1930. From Chem. Abst., **24**: 2186, May 10, 1930. Effect of drinking water containing high concentrations of common inorganic salts on rats and other small animals was studied.—*R. E. Thompson.*

Sterilizing Water with Chlorine. OSCAR ADLER and RUDOLF ADLER. U. S. 1,750,561, March 11. From Chem. Abst., **24**: 2221, May 10, 1930. Chlorine-containing water is first passed over substances such as manganese dioxide or

ferric oxide, which cause heavy metal compounds dissolved in water to separate; it is then passed in contact with carbon in sufficient quantity to convert quantitatively and continuously the excess chlorine into ionized form and may be further treated with calcium carbonate or bauxite.—*R. E. Thompson.*

Ionic Ratios in the Waters of the North Pacific Ocean. THOMAS G. THOMPSON and CALVERT C. WRIGHT. J. Am. Chem. Soc., **52**: 915–21, 1930; cf. C. A., **23**: 2452. From Chem. Abst., **24**: 2400, May 20, 1930. Gravimetric oxalate method for calcium and EPPERSON's modification of the phosphate method for magnesium were found to be the most accurate.—*R. E. Thompson.*

Alteration of Cast Iron (Pipe) in Thickly Settled Regions. A. ROMWALTER. Gas- u. Wasserfach, **73**: 178–82, 1930. From Chem. Abst., **24**: 2411, May 20, 1930. Cast iron pipes in populated districts are subject to attack by contaminated ground water containing much organic material and having high contents of nitrites and chlorides. Pipe subjected to such water is corroded and sudden failure and leaks often occur. Analyses of the cast iron and corrosion products are given. Odor similar to illuminating gas is given off when corrosion products are heated. Corrosion is caused by (1) electrolytic action such as (*a*) small local cells, (*b*) large electrolytic cells formed by various portions of pipe, and (*c*) leakage currents from street railways, etc.; (2) acid corrosion (usually combined with electrolytic action) by acids such as humic and carbonic, and to lesser extent by acid from hydrolysis of iron salts, etc. Action cannot be attributed to oxygen as such water is free from dissolved oxygen. Corroded pipe may have appearance of sound pipe, but corrosion products are easily removed with knife or hammer.—*R. E. Thompson.*

The Routine Preparation of Conductivity Water. II. JOHN M. STUART and FRANK WORMWELL. J. Chem. Soc., 1930: 85–7. From Chem. Abst., **24**: 2332, May 20, 1930. Modifications (based on 5 years' experience) on previous still (C. A., **22**: 7) give one having advantages of (1) lower cost, (2) greater strength and compactness, (3) greater ease of erection and operation, and (4) durability. Water thus far obtained has same conductivity as that from previous still.—*R. E. Thompson.*

The Precipitability of Calcium Salts by Barium Aluminate. HANS J. BRAUN. Metallbörse, **20**: 454–5, 1930. From Chem. Abst., **24**: 2393, May 20, 1930. Possible combinations of calcium salts with barium aluminate are discussed. If calcium aluminate formed were insoluble in water, barium aluminate would make an ideal water softening chemical; but this is not so. It hydrolyzes, to form calcium hydroxide and alumina. Investigations are needed to determine extent to which alumina formed can remove barium sulfate, calcium oxide, etc. (by adsorption, or by formation of molecular complexes).—*R. E. Thompson.*

Convenient and Reliable Method for the Gravimetric Determination of Aluminum as Oxide. R. FRICKE and K. MEYRING. Z. anorg. allgem. Chem., **188**: Schenck Festschr., 127–37, 1930. From Chem. Abst., **24**: 2396, May 20,

1930. Method of precipitating aluminum hydroxide from alkali aluminate solutions by saturating the carefully neutralized solution with carbon dioxide was recommended by ALLEN and GOTTSCHALK in 1900, but has never been used much except in technical work and then chiefly for analysis of aluminates. It is shown here that method, which is described in detail, is very satisfactory for analysis of any aluminum salt.—*R. E. Thompson.*

Microanalytical Determination of Iodine in Organic Substances. T. LEIPERT. Mikrochem , Pregl. Festschr., 266–71, 1929. From Chem. Abst., **24**: 2398, May 20, 1930. Following procedure is recommended: 5 milligrams of material is burnt in oxygen according to PREGL's method, and iodine is absorbed in concentrated sodium hydroxide. Solution is exactly neutralized with 2 N sulfuric acid, 3 drops excess acid added and whole diluted to 60 cc. 2 cc. bromine is added and excess expelled by maintaining solution at boiling point for 7 minutes by vigorous current of steam. After cooling, 1 gram potassium iodide is added, and liberated iodine titrated with 0.01 N thiosulfate.—*R. E. Thompson.*

Testing for Lead Dissolved in Water by the Biological Method of Friedberger. E. FRIEDBERGER and H. HAHSIMOTO. Z. Hyg. Infektionskrankh., **110**: 755–60, 1929. From Chem. Abst., **24**: 2484, May 20, 1930. Biological method for detecting lead in water consists in passing RINGER-LOCKE solution through aorta and veins of lower half of rat or guinea pig and timing flow of drops under constant pressure. When constant rate is reached, lead solution is substituted and rate of dropping is materially decreased.—*R. E. Thompson.*

Filtration and Sterilization of Drinking Water for Municipalities. BOUSQUET. Tech. sanit. munic., **25**: 13–4, 1930. From Chem. Abst., **24**: 2521. May 20, 1930. Cost data are given.—*R. E. Thompson.*

Comparative Studies on pH Determination in Cultures with the Wedge Colorimeter of Bjerrum-Arrhenius, the Hellige Universal Colorimeter and the Hellige Comparator and on the Use of One- and Two-Color Indicators. E. REMY. Zentr. Bakt. Parasitenk., I Abt., **115**: 391–5, 1930. From Chem., Abst., **24**: 2489, May 20, 1930. With BJERRUM-ARRHENIUS and HELLIGE colorimeters, pH can be determinted to ± 0.025, with comparator to ± 0.05.—*R. E. Thompson.*

The Mechanism of the Bactericidal Action of Chlorine. CARLOS A. SAGASTUME and ARTURO A. SOLARI. Rev. facultad cienc. quím. (Univ. La Plata), **6**: Pt. 1, 37–51, 1929. From Chem. Abst., **24**: 2490, May 20, 1930. It has been proposed by BUNAU-VARILLA and TECHOUEYRES (C. A., **19**: 2687) that action of sodium hypochlorite on organic substances results in radiations similar to ultra-violet rays, which act to destroy bacteria. In order to test this hypothesis a series of experiments was carried out based on supposition that radiations would pass through walls of quartz vessels and effect antisepsis at distance. Typhoid and colon bacilli were subjected to possible rays emanating from action of potassium and sodium hypochlorite on urea and egg albumin.

In some cases an apparent checking of bacterial growths was obtained. Results, however, were considered too inconsistent to be conclusive.—*R. E. Thompson.*

The Manganese Content of the Mississippi River Water at Fairport, Iowa. A. H. WIEBE. Science, 71: 248, 1930. From Chem. Abst., 24: 2519, May 20, 1930. Determinations were made on filtered water samples during summer of 1929. Content of surface samples varied from 0.044 to 0.128 p.p.m., with average of 0.0898 on 10 samples. Bottom samples varied from 0.072 to 0.120 p.p.m., with average of 0.093 on 5 samples.—*R. E. Thompson.*

Activated Carbon, Its Preparation, Properties and Applications. M. B. ZAPADINSKII. Neftyanoe Khozyaistvo, 17: 734–6, 1929. From Chem. Abst., 24: 2551, May 20, 1930. Review, with number of references.—*R. E. Thompson.*

The Chemical Changes in Pools Containing Vegetable Remains Infected with Sulfur Bacteria. D. ELLIS and J. HASTIE STODDART. J. Roy. Tech. Coll. (Glasgow), 2: Pt. 2, 336–46, 1930. From Chem. Abst., 24: 2519, May 20, 1930. Investigation was carried out of chemical changes which follow continued development of *Thioporphyra volutans* in shallow pool of sea water. Changes in following were recorded over period of 10 weeks: hydrogen sulfide, oxygen, calcium, magnesium, sulfate, pH, and number of saprophytic bacteria. Results have, for greatest part, confirmed data already obtained by biological study of these organisms. Loss of hydrogen sulfide following growth of sulfur bacteria and continued diminution in pressure of dissolved oxygen following their respiration was noted. Calcium and magnesium in appreciable quantities were not found to be necessary. The pH was approximately same as that obtained for other sulfur organisms. Growth of *Thioporphyra volutans* was not found to be inhibited by presence of excessive organic matter in solution.—*R. E. Thompson.*

The Disinfection of Water with Sodium Peroxide. W. A. UGLOW and I. G. PETRENKO. Z. Hyg. Infektionskrankh., 110: 761–8, 1929. From Chem. Abst., 24: 2520, May 10, 1930. Sodium peroxide is very satisfactory, from bacteriological standpoint, for purifying water in army camps. It can easily be neutralized with citric acid.—*R. E. Thompson.*

Preliminary Purification Processes of Polluted Water. LYLE L. JENNE. Proc. Am. Soc. Munic. Improvements, 35: 293–312, 1930. From Chem. Abst., 24: 2522, May 20, 1930. Short sedimentation periods with preliminary filtration, or with after-coagulation, is most efficient method of preliminary turbidity removal, although sedimentation period of a week, using coagulant, with turbidities somewhat under 50, would be expected to give same results. Plain sedimentation with storage period of about a week is more effective in removing bacteria than short sedimentation period with prefiltration, even when those of mechanical type are employed.—*R. E. Thompson.*

Present Tendency of Boiler-Water Conditions. HALL. Fuels and Steam Power (A. S. M. E. Trans.), 50: 65–75, 1928; cf. C. A., 24: 1688. From Chem. Abst., 24: 2522, May 20, 1930. General discussion of prevention of scale and corrosion in boilers by maintaining pH above 10, hydroxyl alkalinity above 50 p.p.m., correct carbonate, or, preferably, phosphate equilibrium, zero oxygen and carbon dioxide content.—*R. E. Thompson.*

Locomotive Boiler-Feed Water Supplies and Their Treatment. A. V. PATERSON. Chem. Eng. Mining Rev., 22: 181–5; Commonwealth Eng., 17: 249–54, 1930. From Chem. Abst., 24: 2522, May 20, 1930. Across Nullabor plain, good water was obtained by means of reservoirs for conservation of rain water. All other water is highly mineralized. Where storage is not available, only supply is highly mineralized ground water. Foaming was reduced to minimum by use of patent anti-foam compound containing castor oil. Treatment for removal of scale-forming substances consisted in use of lime and barium carbonate. Most of magnesium sulfate and calcium and magnesium bicarbonates are removed. Resulting water, carrying about 4 grains per gallon causticity, gives greatly improved results.—*R. E. Thompson.*

Eliminating Phenols from Water. JOHN T. TRAVERS, CHARLES H. LEWIS and OLIVER M. URBAIN (to Ohio Sanitary Engineering Corporation). U. S. 1,754,068, April 8. From Chem. Abst., 24: 2528, May 20, 1930. Water containing phenol is treated with mixture comprising hydroxides of iron and calcium and a catalyst, such as acid-treated waste dust from cement manufacture, in such proportions that not less than 4.4 grains per gallon of iron hydroxide will be present together with not less than 14.8 grains per gallon calcium hydroxide and not less than 30 grains per gallon of the catalyst-bearing material.—*R. E. Thompson.*

Graphs as an Aid in the Study of the Deacidification of Water. PAUL MARTING. Gesundh.-Ing. 53: 202, 1930. From Chem. Abst., 24: 2817, June 10, 1930. Graphs are given showing relationship between pH and free, half-bound, and bound carbon dioxides.—*R. E. Thompson.*

Chlorine Resistance of Colon Bacilli and Streptococci in a Swimming Pool. W. L. MALLMANN and A. G. GELPI, Jr. Mich. Eng. Expt. Sta. Bull., 27: 3–16, 1930. From Chem. Abst., 24: 2527, May 20, 1930. *B. coli* and streptococci, accompanied by high bacterial counts, were found when chlorine content of swimming pool water was maintained at from 0.1 to 0.2 p.p.m. Former developed tolerance to free chlorine, as evidenced by fact that 0.5 p.p.m. residual chlorine failed to destroy the organisms either in pool, or experimentally in laboratory with cultures isolated from pool. Streptococci, although occurring in pool maintained at from 0.1 to 0.2 p.p.m. residual chlorine, did not develop chlorine tolerance. Occurrence of *B. coli* in swimming pools does not always represent dangerous pollution and should not therefore condemn pool as unsafe. A better criterion of pollution should be devised. The *o*-tolidin test should never be sole reliance: bacteriological tests should be made at least twice weekly. Occurrence of streptococci in swimming pools with residual

chlorine content of from 0.1 to 0.2 p p.m. indicates that chlorine dosage as insufficient for safety. It seems that pool water may be maintained at drinking water quality if residual chlorine content reaches 0.5 p.p.m. each morning and never falls below 0.2 p.p.m. at any time. Search for streptococci and micrococci might afford better criterion of swimming pool safety than search for *B. coli*.—*R. E. Thompson.*

Prevention of Sugar Losses During Milling Using Chlorine. J. N. SARKER. Rev. Agr. Mauritius, **42**: 258–63, 1928. From Chem. Abst., **24**: 2630, May 20, 1930. Description in detail of advantages of use of comparatively new hypochlorite compound, known as E. C., in combating bacterial infections. RIDEAL-WALKER coefficient at 20° is from 6 to 7; available chlorine, 2.5 percent. It is claimed the compound will retain its full activity in presence of organic matter.—*R. E. Thompson.*

An Instrument for Sampling Marine Muds. H. B. MOORE and R. G. NEILL. J. Marine Biol. Assoc. United Kingdom, **16**: 589–94, 1930. From Chem. Abst., **24**: 2642, June 10, 1930.—*R. E. Thompson.*

Practical Problems of Corrosion. VI. Some Outdoor Tests of Protective Painting. Preliminary Report. U. R. EVANS and S. C. BRITTON. J. Soc. Chem. Ind., **49**: 173–80T, 1930; cf. C. A., **22**: 2135. From Chem. Abst., **24**: 2619, May 20, 1930. Details given of results of exposure tests of protective paints. It appears that oxidizing pigments inhibit rust formation underneath coating. Smoothness of surface and purity of metal retarded early development of rust, but later there was little to choose between various panels covered with same paint. Following preliminary statements are made: (1) rust below paint, whether dry or damp, accelerates stripping of paint; (2) rusty surfaces, painted in morning, fail more rapidly than such surface painted in afternoon; (3) artificial drying of rusty surface before painting proved unsatisfactory; (4) presence of scale retards "frontal attack" but may favor "undermining attack;" descaled panels rust more quickly than scaled panels, and hence descaling should be immediately followed by painting; (5) wire-brushing of scaled panels proved beneficial; (6) freshly mixed paints containing but little oil and thinner are to be preferred; (7) oil paints proved superior to nitrocellulose lacquors; (8) red lead proved to be the superior pigment on rust-free surfaces, graphite being equally as good except in marine atmosphere; but iron oxide gave best results over rusty surfaces; (9) bitumastic proved superior to aluminum paint, but latter was obtained ready-mixed; (10) coatings on rust-free panels did not suffer from extreme temperature changes; (11) storage of red lead paint for 9 days before painting seemed to have no harmful effect on protective quality, even with "ordinary" red lead.—*R. E. Thompson.*

Determination of Minute Amounts of Iodine in Soils and Waters. R. L. ANDREW. Analyst, **55**: 269–77, 1930. From Chem. Abst., **24**: 2690, June 10, 1930. Many soils and waters were examined in connection with study of endemic goiter in New Zealand. Method used is described in detail in original.

Study was made of completeness of extraction. With waters, between 50 and 60 percent of total iodine was recovered. Iodine content of waters varied from 0.4 to 12 γ per liter.—*R. E. Thompson.*

Supplying Troops in the Field with Potable Water. EDGAR ERSKIN HUME. Water Works Eng., 83: 19, 1353, September 10, 1930. Military requirements such as mobility of troops, simplicity and rapidity of treatment processes, concentrated bulk and availability of apparatus and low costs impose definite restrictions on methods of purification of water supplied to field troops. The principle of disinfection by means of hypochlorite has been most satisfactory. The Lyster bag now in use in the United States "consists of specially woven flax bag sewn into a galvanized iron ring, hinged so that it folds at one diameter. At four equidistant points on the ring, pieces of rope are spliced so that the bag may be suspended on any convenient support. Five nickel, self-closing faucets are placed at equal spaces about the bottom of the bag. The empty bag weighs 5½ pounds and folds up into small space. The calcium hypochlorite used for disinfection contains 30 to 32 percent available chlorine and is packed in brown glass tubes containing 1 gram or 15 grains each. To insure proper disinfection the orthotolidine test for free chlorine in the treated water is employed and sodium thiosulphate is used for dechlorination after a thirty-minute period of contact. Detailed instructions for the operation of the Lyster bag treatment process are given. In cases of emergency the use of tincture of iodine may be used as a substitute for hypochlorite. The addition of 5 cc. of this tincture (containing 7 percent iodine) to the contents (36 gallons) of a Lyster bag will render polluted water safe within thirty minutes. In special instances the use of water carts may be necessary and under other conditions, mobile pressure filter units may be possible. Such a mobile plant is described.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The Bacteriological Findings in the Chlorinated Water Supply of a Large City in the Tropics. G. MACKEY. Indian Medical Gazette, 65: 7, 381, July, 1930. This is a report of findings in the water supply of Rangoon, Burma. The supply is chlorinated at its source—a lake 17 miles distant from the city—and consistently showed: "Lactose fermenters absent in 100 cc. with a negligible total count" at that point. At points of examination within the city lactose fermenters were found in 10 cc. portions. Residual chlorine at collection points varied from a trace to 0.2 p.p.m. The author concludes that examination of water shortly after chlorination and before it goes through an extensive distributing system is unreliable. Further work is urged to determine the source of the pollution observed at delivery points.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Why Bother with Bug and Chemical Tests at Small Water Works Plants? J. M. JESTER. American City, 43: 3, 167, September, 1930. The author points out the desirability of making certain daily tests at small filtration plants and of recording the results. The following points are noted: (1) sampling—the proper method of taking samples; (2) turbidity—the value of this test and how to make it; (3) hydrogen ion concentration—what the test

means and how to make it; the cause and elimination of red water troubles are stated; (4) hardness—how the test is made and its value; (5) residual chlorine—how to make the test and maintain accurate control; (6) taste and odors—how to make the test and its value.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

A Study on the Term of Existence of Typhoid Bacilli in Hot Spring Water and Others. N. WATANABE. The Journal of the Public Health Association of Japan, **6**: 6, 1, June, 1930. The results of the investigation of the longevity of typhoid bacilli in several different kinds of water and under various conditions are given in this article. Typhoid bacilli, isolated from a healthy carrier, were introduced into the water at various dilutions. A table is shown for each type of water and the following conclusions are made: (1) in the polluted water of Iizaka hot spring, typhoid bacilli disappeared more quickly than in the clear water of that spring; (2) there was not much difference between the term of existence of typhoid bacilli that were put into the water of Iizaka hot spring and that put into Fukushima waterworks, and that should the bacilli gain entrance into such water, it must be thought that the bathers are exposed to the danger of infection; (3) the water of Nakanosawa and Takayu hot springs both have certain disinfecting properties, and typhoid bacilli put therein perish very soon; (4) it was proven that in the water of Fukushima waterworks typhoid bacilli could live 12 days in summer months and 18 days in winter, if the dilution were 1/100; (5) in a test tube, there is a tendency of typhoid bacilli living slightly longer in the water of Inawashiro Lake than in the water of Fukushima waterworks.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Roadside Drinking Fountains—Notable Development in Oregon. The American City, **43**: 1, 146, July, 1930. About thirty artistically designed roadside fountains have been constructed and properly designed as "Safe Highway Water Supplies" by the Oregon State Highway Commission. Native materials have been used in the construction with an effort to design the fountain so that it harmonizes with the surrounding landscape. All water supplies are tested by the State and in most instances the standards of sanitation developed by the Committee on Plumbing of the American Public Health Assoc. are followed in the design. The construction is estimated to cost between $200 and $300 per spring.—*A. W. Blohm* (*Courtsey U. S. P. H. Eng. Abst.*).

Eliminating Suspended Matter from Water. J. W. CUNNINGHAM. Public Works, **61**: 10, 55, October, 1930. A general discussion of intakes, intake racks, screens, coarse and fine, with and without automatic cleaning, combined with sedimentation for the removal of silt, sediment, brush, pine needles, leaves, etc., from surface waters. The water works intake and screening plant is of an importance which deserves more thorough study and careful design than it receives. The plant operator usually realizes this more fully than the designing engineer but the engineer is better able to apply the various hydraulic and mechanical principles which go into the design if he will only do so.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The Removal of Bacteria from Polluted Water. A. J. HALL. The Municipality, 25: 9, 203, September, 1930. The author discusses water purification in general. The methods and care required for the operation of water purification plants are considered.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Municipal Works of Johannesburg. E. H. WAUGH. Surveyor, 73: 2010, 125, August 1, 1930. Water supply: Water is delivered in bulk by the Rand Water Board to four reservoirs, combined capacity 16.5 million gallons, and thence distributed through 477.3 miles of mains. The average daily consumption in 1929 was 5.94 million gallons. Further statistics are given.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Micro-titration of Iodides in the Presence of Nitrites. J. F. REITH. Versl. Meded. Volksgezondheid, 1930, 8: 1495. The micro-titration of iodides is possible if the nitrites are destroyed with sodiumazide (NaN_3). For determination of iodine quantities of 0.2 to 1 part per billion a colorimetric method is proposed. The standard is made by mixing 3 parts of amylum solution with 1 percent Kl solution. The determination is said to be simple.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

A-typical Coli-bacteria and Examination of Drinking Water. J. W. DE-WAAL. Versl. Meded. Volksgezondheid, 1930, 9: 1602. It is suggested to differentiate the colon organisms by incubating at 37° and 45°C. as suggested by McConkey but to add gall-like substances to the lactose as nutriment.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Weiser, Idaho, Water Treatment Plant. MAX C. BARTLETT. Western Construction News, 5: 17, 425, September 10, 1930. This is a description of the water filtration plant which is being built by the city of Weiser, Idaho. The source of supply is the Snake River. The treatment is to consist of aeration, sedimentation with coagulation, rapid sand filtration and chlorination. The plant is to be so designed as to permit prechlorination and addition of ammonia in the raw water as well as in the filter effluent. The following subjects are briefly discussed: (1) improvements to supply works; (2) filtration plant; (3) chemical handling; (4) pumping equipment; (5) operating tables, gauges and meters; (6) plant building and (7) cost of plant.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Report of the Government Bureau for Water Supply, 1929. W. F. J. KRUL. Versl. Meded. Volksgezondheid, 7: 1001, 1930. Detailed report dealing with municipal and "group" water supplies. Group water supplies are for groups of cities and towns and in some cases for whole provinces. There are at present still some 600 small water treatment plants, which "miniature" plants the writer considers as stumbling blocks for a real unified water supply. In the western part of the Netherlands, where it is difficult to find sufficient good water, centralization and concentration will be necessary in the near future. Such centralized water supplies can afford higher technical supervision for treatment, produce hygienically better water and have better control in

connection with reduction in iron and manganese.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The Manganese Content of the Mississippi River Water at Freeport. A. H. WEIBE. Science, 71: 1835, 248, February 28, 1930. Because of the fact that normal growths of plants, in many instances, depend on the presence of small amounts of certain metals, the author secured samples of Mississippi River water and analyzed them for manganese. Results are shown in an accompanying table.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Sterilization of Water Mains. G. T. LUIPPOLD. Arizona State Board of Health Bulletin, 54: 26, July, 1930. Blowing off the lines is unsafe and not reliable. Calcium hypochlorite treatment is likewise not satisfactory since the salt loses its strength very rapidly when exposed to the air. The almost universal method now employed is to sterilize by means of liquid chlorine. Solution feed is superior to dry gas because it gives a much better diffusion through the mains. The chlorine should be applied on the suction side of the pump, and continued until a residual is obtained as indicated by the ortho-tolidine test. A check of the sterilization should be made by making bacteriological test for B. coli.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Controlling Algae Growths at Winslow. R. C. CLINE and D. E. LEWIS. Arizona State Board of Health Bulletin, 54: 28, July, 1930. During the middle of July, 1929, a storm in the mountains south of Winslow caused considerable runoff in the drainage area of Clear Creek and much debris, refuse and silt was carried into the dam where the city water supply was stored. Within a few days the domestic supply developed an offensive taste and odor. An inspection of the supply showed it to be due to algae. The reservoir was drained and thoroughly cleaned and the side walls brushed with a solution of copper sulphate. Copper sulphate was also added just above the intake to the reservoir, and the chlorine dosage of the water was increased as much as practical. By increasing the dosage from the reservoir to the distributing system practically all of the taste and odor was eliminated. The combination of copper sulphate treatment plus increased chlorine dosage very effectively stopped the taste and odor trouble.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Titrimetric Determination of Calcium and Magnesium in Drinking Water. M. E. STAS. Versl. Meded. Volksgezondheid (Holland), 8: 1432, 1930. The possibility of using Von Luck and Meyers method of determining calcium and magnesium in river water for drinking water was determined by a modified method. The calcium as oxalate and the magnesium as magnesium-o-oxychinolate. The method is rapid and dependable.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

State Control of Sewage Disposal and Pollution of Public Waters in Rhode Island. ESKIL C. JOHNSON. Sewage Works Jour., 2: 1, 101, January, 1930. The powers and duties, as well as the operation of the Rhode Island Board of

Purification of Waters, is given. Very broad powers are vested in the Board which controls the streams as well as the tidal waters within the State. Although the Board has ample authority it endeavors to coöperate with those responsible for pollution and accomplish abatement without legal action. Appeal from orders from the Board must be made to the Supreme Court.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

State Aid for Water Works in New South Wales. R. J. BARRETT. American City, **43**: 3, 155, September, 1930. There are four geographical divisions in New South Wales and the possibilities for obtaining adequate water supplies in each are discussed. The supplies at Sydney and Newcastle are described together with the method of serving smaller communities. There is considerable construction in progress at the present time which is financed by the State Government and the capital cost repaid over a period of forty years. The policy of the New South Wales Government is to assist local development by enabling councils, by financial assistance and expert advice, to provide water supply and sewerage services.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Los Angeles Successfully Reclaims Sewage for Replenishment of Underground Water Supplies. CARL WILSON. Western Construction News, **5**: 18, 473, September 25, 1930. Because of the continued rapid growth in population of Los Angeles and surrounding country the time is believed to be approaching when it will be impossible to obtain sufficient fresh water from natural sources to supply the demand. An experimental plant was therefore built to investigate the possibilities of reclaiming sewage. The plant is of the activated sludge type with a capacity of 200,000 g.p.d. and has been in service since May, 1930. This article stresses the need for additional water and outlines the program of water reclamation studies under the following topics: (1) volume of municipal waste water available; (2) character of waste waters; (3) treatment of municipal waste waters; (4) types of reclamation under consideration and research involved; (5) resources available in reclamation; (6) coöperation with agencies outside the city of Los Angeles; (7) definite recommendations.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Sewage Reclamation Plant for Los Angeles. R. F. GOUDEY. Western Construction News, **5**: 20, 519, October 25, 1930. In order to study sewage reclamation, the city of Los Angeles placed in operation on May 12, 1930, an experimental sewage treatment plant of 200,000 g.p.d. capacity. There is rather complete and interesting description of this undertaking, with sample record forms and photographs. The subject is discussed under the following headings: (1) design of plant; (2) description of plant; (3) intake works; (4) sedimentation work; (5) aeration and sedimentation; (6) filtration of final effluent; (7) spreading grounds; (8) sludge disposal; (9) cost data; (10) what the plant is accomplishing.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Institutional Water and Sewage Treatment Plants in New Jersey. G. M. RIDENOUR. Public Works, **61**: 8, 38, August, 1930. "The State of New Jersey

has realized its responsibility in this respect and rapid strides are being made in placing the State Institutional water and sewage plants where they rightfully belong in the field of sanitation. This has been made possible through the constructive attitude and progressive spirit of Mr. Ellis, State Commissioner of Institutions and Agencies, whose department approves all new state institutional projects. Two years ago an arrangement was made whereby the design of new plants and supervision of operation were to be performed by the Department of Water Supplies and Sewage Disposal of the New Jersey Agricultural Experiment Station in coöperation with the State Department of Institutions and Agencies and the State Board of Health."—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Studies on the Dissolved Oxygen Absorption Test. IV. E. A. COOPER and S. D. NICHOLAS. J. Soc. Chem. Ind., **49**: 119–20T (1930); cf. C. A., 23,923. Chemical Abstracts, **24**: 13, 3297, July 10, 1930. "Variation of temperature and proportion and concentration of Na molybdate and H_2O_2 had no effect in preparation of the catalyst in Na permolybdate solution which accelerates the absorption of O_2. A 1:5000 solution of Na molybdate is without effect in the oxidation of dextrose by air, but after treatment with H_2O_2 the solution markedly accelerates the rate of oxidation. Alkali induces oxidation of sugar but the catalytic activity of the 'permolybdate' solution is not due to its slight alkalinity, and addition of alkali sometimes inhibits its effect. The oxidation of sugar in alkaline solution is often retarded by the catalytic 'permolybdate' solution. The catalytic effect of permolybdate solution in treatment of 0.1 to 2.0 percent solutions of dextrose for 2 weeks was too small for the sugar oxidized to be detected. The catalyst is probably highly unstable and decomposes during catalysis. Na molybdate had an inhibitory effect on the hydrolytic action of castor seed lipase toward the seed fats even after 24 hours. The permolybdate slightly stimulated the action after 1 hour but on longer standing was slightly inhibitory."—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Chemical Precipitation of Humus Colouring Matters. C. P. MOM and O. H. VAN DER HOUT. Mededeelingen Van Den Dienst Der Volksgezondheid in Nederlandsch-Indie, **19**: Part I, 23, 1930. II. The Purification of peat water at Pontianak. The water is dark brown, tastes sour, and reacts strongly acid. It comes from marshes with an upper layer of 1.5 to 2 m. of peat over clay. Approximate color 2000° on Pt-scale, colloidal. pH 2.9 to 4.2; permanganate index 300 to 380 mgm. per liter; iron index from 1.7 to 2.7 mgm. per liter. Analysis is given showing water poor in salts (table I). Table II shows a coagulation experiment with aluminum sulphate. Table III gives variations from various quantities of aluminum sulphate in water held at different acidities. Results show optimum pH for decolourization at 4.0, organic impurities remain too high for drinking water. Neutralization had to be held down to pH 6.0 in the water so poor in salts, since with higher pH aluminum will remain in solution as an aluminate. This difficulty led to trial of iron salts as coagulants. Tables show trials with ferrous sulphate, ferric chloride, and chlorinated ferro sulphate. Ferrous sulphate and lime gave poor results. Full precipitation at pH 10.0 or more. Coagulation was caused by the cal-

cium hydrate. Ferric chloride gave markedly better results with high degrees of acidity. With chlorinated ferro sulphate the optimum pH was 3.0. With excess chlorine in the coagulant solution complete decolourization was impossible. The free chlorine modified the colloids. Also, with ferrous sulphate not completely chlorinated, the results were unsatisfactory. The high acidity and iron of the decolourized water compel further purification. Lime was added. Table 8 shows that at the point of complete iron removal (pH about 9.0) the maximum organic matter is also removed.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Banagher Water Scheme, Londonderry. Surveyor, 78: 2025, 487, November 14, 1930. The connecting up of the pipe lines under the river Foyle marks another stage in the progress of the scheme which will provide the city of Londonderry with a full supply of pure moorland water from the gathering grounds in the Sperrin Mountains, 20 miles distant. The completion of the pipe lines will enable the water to be passed across the river direct to the service reservoirs. Filtration of the water mainly for the purpose of removing peat stains, is carried out by means of a battery of 21 Paterson pressure filters, having a present capacity of 3,000,000 gallons per day. The filters have been recently completed and are now in operation. The greater part of the article covers in detail the methods used in connecting and lowering the pipe lines under the river Foyle.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The Reforestation of Public Water Supply Watersheds. JAMES O. HAZARD. Water Works and Sewerage, 77: 10, 366, October, 1930. A complete ground cover can be provided in from 7 to 10 years. Notes within past 30 years: planting in Massachusetts of 2,663,000 trees in 86 town forests, 19 on used watersheds; in Connecticut, 20 political districts own watershed protection forests of 23,000 acres, 1000 acres of which have been reforested by planting 1,200,000 trees—three private companies owning 40,000 acres planted 4,357,000 trees; in New York State two-thirds of the cities planted forests around water supply sources, 12 cities planted 10,224,400 trees mostly on watersheds; in New Jersey, 15 watersheds are being reforested; in Pennsylvania 122 water companies have planted 10,000,000 trees since 1910. At York, Pa, Norway spruce are planted next the flow line to prevent falling leaves from entering the reservoir. "Forested watersheds, aside from protecting the water supplies, can be kept attractive and made revenue producing by the practice of forestry." The proper harvesting of the tree crop is ah effective means of maintaining watershed protection forests.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Good Results from Operation of New 24 m.g.d. Filtration Plant. A. B. JEWELL. Water Works Eng., 83: 18, 1277, August 27, 1930. This article consists of a description of the new water treatment plant at Tulsa, Oklahoma, and the favorable results obtained during the first three months of operation. The source of supply is that of Spavinaw Lake, a twenty billion gallon impounded reservoir about 55 miles east of the city. The water is brought by gravity from the lake to the plant. The treatment consists of primary sedi-

mentation, aeration, coagulation, filtration and chlorination. Previously, during periods of high turbidity (200 to 300 p.p.m.) the surplus water delivered having been diverted to Mohawk Lake, a 500 million gallon reservoir located near the pump station, this supply was drawn upon in order to take advantage of the twenty- to thirty-day detention period. With the new plant this reservoir may be used, but usually the supply is taken directly from the Spavinaw line. Some trouble was experienced with algae, also with daphnia, and prechlorination tried. It is found that a residual of 0.9 p.p.m. maintained in the raw water flume has increased filter runs from approximately 20 hours to the present average of 45 hours with reduction in wash water from 2.59 to 1.3 percent. The average cost of treatment during the three-month period, March, April and May, 1930, has varied from $4.63 to $6.60 per million gallon. —*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Modern Water Supply Plants and Chemical Soil Hardening Methods. A. LANG. Gas. u. Wasserfach, **73**: 789–93 (1930). Chemical Abstracts, **24**: 21, 5396, November 10, 1930. "Methods of preparing wells which are connected at the bottom to common collecting or pumping mains are discussed. The lower parts of the wells are made impervious to water by the chemical hardening process, which consists of forcing solutions of water glass and $CaCl_2$ into the soil. This type of well is more or less independent of changes in groundwater level. Illustrations are given."—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Significance of Bacteria Found in Water Sources. CASSANDRA RITTER. Water Works Eng., **83**: 18, 1302, August 27, 1930. Classification of bacteria is given herein by the author, and particular reference made to the metatrophic group which thrive on the food supply of the soil and are therefore present in large numbers in surface layers. The usual means of introduction of these forms to surface water through rainfall and the influence of meteorologic conditions on these forms, such as prolonged rainfall and temperature, is discussed briefly. Storage and sedimentation is referred to as having a very definite effect on the number of water bacteria, and the importance of food supply is stressed.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Increasing the Efficiency of Small Plant Operators. J. SUMMIE WHITENER. Water Works Eng., **85**: 17, 1231, August 13, 1930. An excellent description of the work accomplished by the Bureau of Sanitary Engineering of the North Carolina State Board of Health in training filter plant operators who are, in addition, in many cases, operating sewage treatment plants and have control of milk sanitation.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Bacterial Aftergrowths in Water Distribution Systems. JOHN R. BAYLIS. Water Works and Sewerage, **77**: 10, 335, October, 1930. The author presents four tables of results of experiments to show that B. coli will grow on decaying microörganisms; that B. coli will increase to a great extent in sterile water containing sterile sediment; that B. coli will decrease in water containing sediment not sterilized. Concludes that "microörganisms that do not live in

the dark, when carried into the distribution system die and furnish food for bacterial growths, unless the water contains residual chlorine all the time. Bacterial growths in water distribution systems are dependent upon the water containing food for the growths, and upon it being free from sterilizing agents such as chlorine. Bacterial increases are usually without sanitary significance except that such increases might mask unexpected contamination. To avoid aftergrowths, water should be free from suspended organic matter or matter (such as Mn and Fe) that will form a gelatinous coating on pipes, and be low in organic compounds that support bacterial growths. If this is not possible, the water should contain a residual of chlorine throughout the entire system. Biological growths in open reservoirs should be prevented at all times."—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

How a Typical Rural Community Supplied Itself with Water. LEWIS V. CARPENTER. Water Works Eng., 83: 23, 1647, November 5, 1930. Blacksville, Virginia, is a rural community situated in the foot hills of Cheat Mountains. Its population is 358. A well 160 feet deep and 6 inches in diameter was drilled but the water was high in chlorides and had a brackish taste, though there was an abundant flow. After considerable searching for a water freer from chlorides the first well was accepted because the $11,000 available did not permit further searching. A 50,000 gallon storage tank was erected and a centrifugal pump installed.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Stored Water, Stream Flows and Impounding Reservoirs. Surveyor, 78: 2025, 489, November 14, 1930. A discussion of a paper entitled "Stored Water: How to Get, Preserve and Improve It," published in *Engineering News-Record* by E. B. Whitman, under the following headings: storage provisions, estimation of stream flow, reservoir sites, dams, silting, clearing reservoir sites, and other requirements. Reference is made to Sir Alexander Houston's conclusion that 30 days quiescent storage of water in open reservoirs is practically equivalent to filtration.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The Land Drainage Act 1930 in Relation to River Pollution Prevention. A. BEBBINGTON. Surveyor, 78: 2027, 564, November 28, 1930. The Land Drainage Act, 1930, follows very closely the recommendation of the Royal Commission on Land Drainage, 1927. It repeals all public statutes relating to land drainage and places the drainage of a catchment area under the jurisdiction of a catchment board consisting of representatives appointed by the Ministry of Agriculture and Fisheries. The plan of the Act is to divide the country into catchment areas and for each catchment authority to subdivide its area into internal drainage districts. Drainage boards may make by-laws to prevent obstruction caused by the discharge of solid or liquid matter into the streams. The Act introduces a new principle by which the whole of the land in a catchment area can be called upon to contribute towards the cost of drainage works on the main river.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Bacterial Aftergrowths in Water Distribution Systems—Committee on Water Supply. American Journal of Public Health and the Nation's Health, 20:

5, 485, May, 1930. A report giving a brief digest of information regarding bacterial aftergrowths obtained from 48 cities. Fourteen cities reported they were having or have had trouble from bacterial aftergrowths. Bacterial increases, especially in B. coli, tend to render unreliable our main criterion for judging the safety of water. Water from all reservoirs, tanks, etc., should be frequently tested. Reducing the number of open reservoirs to minimum and continuously chlorinating water from open reservoirs are urged.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

The Minimal "Chlorine Death Points" of Bacteria. FRED O. TONNEY, FRANK E. GREER and GEORGE F. LEIBIG. Journal of Public Health and the Nation's Health, **20**: 5, 503, May, 1930. A description of the technic employed in determining the chlorine death point of bacteria is given. Resistance to chlorine divides bacteria studied into two groups. The vegetative group, including the common pathogens of both intestinal and respiratory origin, (exclusive of tubercle bacillus) were killed by small doses of free chlorine, i.e., 0.15 to 0.25 p.p.m. in 15 to 30 seconds. B. coli was found to be a suitable index organism for use as a criterion of effective disinfection by chlorine. The chlorine death point of the spore bearing group ranged from 2.5 to 280 p.p.m. (killed in 15 to 30 seconds). B. subtilis with a chlorine death point of 160 p.p.m. is best adapted for use as index organism. It is futile to attempt to eliminate spore-bearing bacteria from water supplies by chlorination.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Afforestation of Watersheds. R. L. ROBINSON. Surveyor, **78**: 2007, 34, July 11, 1930. The state planting program for the decade 1929–39 has been approved at 353,000 acres. The water engineer is interested in afforestation from the standpoint of quality and quantity. Forests tend to increase quality by reducing to a minimum the presence of human beings and higher animals of the area. Forests equalize run-off, tend to keep springs replenished and minimize erosion and consequent silting. The Forestry Commissioners are anxious to assist municipalities in the afforestation of catchment areas. The general methods employed in the encouragement of forestry are presented.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Machine Washing of Sand at Richmond Filtration Plant. GEORGE A. ROBERTSON. Water Works Eng., **85**: 17, 1248, August 13, 1930. Encrustants, composed largely of sulphite and other trade wastes in the raw water, rendered cleaning or replacement of sand imperative. The author developed a machine for washing sand at a cost of 94 cents per ton. Loss of sand due to machine washing was less than one-half of 1 percent. The sand actually lost 22.5 percent due to removal of encrustants which had accumulated on the sand grains over a period of years. Despite the purchase of considerable new sand, the saving amounted to over $800 per filter had washing not been resorted to.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Chloramine, Its Preparation, Properties and Uses. W. HIRSCHKIND. Western Construction News, **5**: 20, 531, October 25, 1930. Chloramines were first

discovered by Raschig in 1907, whereas Rideal in 1910 and Race in 1915 pointed out their excellent bactericidal properties which greatly exceeded those of chlorine alone. The compounds are monochloramine (NH_2Cl); dichloramine ($NHCl_2$); and nitrogen trichloride (NCl_3). The following subjects are discussed in this article: (1) chemistry of chloramine compounds; (2) properties of chloramines; (3) application of chloramines.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Purification Problems, and Their Solution, At Norfolk. R. W. FITZGERALD. Water Works Eng., 85: 17, 1228, August 13, 1930. Corrosion was corrected by adding lime to produce an alkalinity to phenolphthalene of 6 to 8 p.p.m. To preserve the thin coating established on the pipe walls pH values were kept between 8.3 and 8.5 with checks every two hours or better. Color which varied from 20 to 200 p.p.m. was controlled somewhat by continuous blowing off the water at the bottom of the lake which was the source of raw water. Algae troubles occur at different times and during which time chlorine and then chlorine and ammonia were tried. Chlorination of the raw water was finally adopted and has proved satisfactory so far.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

New York State Plumbing Regulations for Property Served with Water Outside Municipal Limits. American City, 43: 5, 161, November, 1930. This article is a summary of report No. 1147 of the New York State Bureau of Municipal Information upon the regulations of plumbing for water services outside corporation limits of various cities and large villages in New York State. It appears that such plumbing regulations do not exist in many municipalities, but where regulations do exist they usually are made to apply likewise to areas outside of the corporate limits, which may be supplied with water from municipal systems.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Colorado River Water Suitable for all Uses. Western Construction News, 5: 20, 515, October 25, 1930. This article was written to disprove statements appearing in the press and elsewhere that the water would be unsuitable for Los Angeles and environs. Some have claimed that the silt could not be settled out or filtered except at great cost; others that the great salt beds in the Boulder Canyon Reservoir site would be dissolved and make the water unsatisfactory; and still others that the total mineral hardness would be excessive. The United States Geological Survey has taken samples of water from the river at frequent intervals since 1925 and made chemical analyses. There is a table in this article showing results of chemical tests and discussions on the salt content and mineral characteristics.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Aeration Corrects Taste and Red Water. K. W. GRIMLEY. Public Works, 61: 12, 29, December, 1930. A water supply of the Alabama Water Service Company supplying a suburb of Birmingham developed a taste and was corrosive due to low alkalinity and a carbon dioxide content of 46 parts per million. The pH was less than 5.2. Treatment with lime was not satisfac-

tory because the consumers objected to adding chemicals to the supply. An aerator was, therefore, installed, consisting of five tiers of 15 wooden trays, holding small size coke. This aeration of the water results in an increase in the pH from 5.2 to 6.5, and a reduction in the carbon dioxide content to 5 p.p.m. The aerated water was further treated by being exposed to a block of "Purite," which is compressed sodium carbonate, manufactured by the Mathieson Alkali Works. One cake of this material is dissolved in about 8 hours by the water, and the pH raised from about 6.5 to 7.4. This treatment has greatly improved the taste and appearance of the water—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

The Determination of Total Alumina in Filtered Water. F. O. BALDWIN. Water Works and Sewerage, 77: 9, 311, September, 1930. The apparatus and reagents required, for the determination of residual alum, are described. The determination requires less than ten minutes and is sensitive to one part in ten millions as Al_2O_3. Alum added after the optimum point of coagulation has been reached is wasted unless short retention requires quick settling. The short length of time required for this test, together with its accuracy, makes it of great value in eliminating excess alum dosage.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Recent Developments in Chlorination. FRANCIS D. WEST. Public Works 61: 12, 23, December, 1930. The nascent oxygen, toxicity and the radiation theories of the disinfection of water and sewage by chlorine compounds are briefly reviewed. The adherence to the second or toxic theory is indicated in the paper. The author holds that chlorinating action is the same per unit of chlorine whether dry gas, a solution or a hypochlorite compound is used as a disinfectant, but points out the great necessity of thoroughly mixing the chlorine and the water or sewage as quickly as possible. It is indicated that an alkaline reaction is more favorable to chlorination than an acid reaction. As the amount of residual chlorine in a water or sewage is a controlling factor rather than the total dose, immediate and effective mixing of the chlorine dosage is indicated, otherwise over-chlorination of some portion of the water will result. The advantages of chlorinating potable water, swimming pools and sewage with ammonia-chlorine treatment are discussed. Brief mention is made of the development in Germany of passing chlorine solution through a container holding copper chips. This leads to the presence of a small amount of copper chloride which has been found to be very much more effective as an algaecide than much larger quantities of chlorine or copper sulfate.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

Water Supply, Sewage Treatment and Refuse Disposal in 1930. H. BURDETT CLEVELAND. Public Works, 61: 12, 26, December, 1930. Attention is called to the decreased activity in the purchase by holding companies of privately owned water supplies on the one hand and on the other hand of the increased number of privately owned plants which have been purchased by municipalities. Increased attention to the formation of water districts and joint projects is noted. A large majority of the water companies throughout the north-

eastern states are said to be planning for extensive reforestation of their watersheds. From the legal side, the questions raised by the attorney general in connection with the Delaware River development by New York City and the Swift and Ware River diversion cases, both now before the Supreme Court, as to the extent of control which may be exercised by the Federal Government over all streams, whether navigable or tributary to navigable streams, is considered as requiring much engineering study. The serious problems which have been presented in many parts of the country by reason of the extended drought are touched upon and the author concludes that it is to be expected that steps will be taken at many points as a result of shortages to increase the safe yield of public water supply sources. A brief summary is presented of the larger projects under way or authorized. The more important developments in water supply treatment are considered as the increasing adoption of the ammonia-chlorine treatment, the successful progress in the use of activated carbon and the conclusion reached at Columbus that the excess lime method of water softening is considerably cheaper than the lime soda process. —*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Rules and Regulations for a Water Company. R. H. COREY. Water Works Eng., 83: 22, 1611, October 22, 1930. These rules specify the relationship between the company supplying the water and the consumer. The regulations are given in detail to cover all conditions that may be encountered under the above relationship.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Pollution of Rivers and Streams. Surveyor, 78: 2027, 549, November 28, 1930. At the conference held at the Royal Sanitary Institute a resolution was passed welcoming the power conferred upon the Minister of Health by the Land Drainage Act of 1930 to set up rivers boards and urging the Minister of Health to make a survey of all rivers which are not already provided with rivers boards with a view to the formation of such boards wherever this may be considered desirable.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Occurrence of Typhoid-paratyphoid Bacilli in Sewage. R. S. BEGBIE and H. J. GIBSON. British Medical Journal, 3627, 55: July 12, 1930. The difficulty of determining the presence of typhoid-paratyphoid carriers in a community by present methods led to the examination of sewage as a means of determining the presence of dangerous carriers. Cultural methods were employed in examining the sewage of Edinburgh for typhoid-paratyphoid bacilli and a technique evolved which was fairly rapid, simple and which seemed to give consistent results.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Borough of Hornsey Swimming Pool. Surveyor, 78: 2021, 371, October 17, 1930. The Hornsey open air pool was opened on June 1, 1929. The attendance during the first season was nearly 50,000 persons per month. The receipts were £4,127 and the expenses were £2,390 for the season. The large attendance made improvements in the original scheme necessary. The dressing facilities were insufficient and were enlarged from 150 boxes to 254 boxes and 400 steel

lockers. The original grass lawns were taken up and replaced with cement paving and two sand beaches, as the lawns became muddy from use and grass was carried into the pool by bathers. The improvements aid greatly in keeping the pool, locker rooms and walks in a cleanly condition and provide more space for the bathers to change. The attendance during the 1930 season was somewhat less than for 1929 but it appears that the revenue for the year will be satisfactory.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*)

An Epidemic of Bacillary Dysentery in the United States Fleet. W. H. Bell U. S. Naval Medical Bulletin, **29**: 1, 139, January, 1931. During March and April, 1930, an epidemic of dysentery and other intestinal infections occurred among the personnel of various United States ships in the Guantanamo, Cuba, area. This thorough report of the epidemic presents considerable pertinent data with the view of determining the causative factors and of formulating effective methods of prevention. Among the conclusions arrived at are: that sufficient laboratory evidence was obtained to characterize the epidemic as one of bacillary origin; that the original source of the infecton was at the Isthmus of Panama from whence it was conveyed to Guantanamo Bay; that the principal means of spreading the disease was through contact with Guantanamo harbor water.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The New Water Supply Development at Griffin, Georgia. R. G. Dicklin. American City, **43**: 5, 113, November, 1930. Previous to 1921 the city of Griffin, Georgia, obtained its water supply from small diameter deep wells. As the town grew this source of supply became inadequate. The city commissioners in 1921 retained engineers to make a survey of the water supply needs of Griffin and report on the most feasible source of supply. The study indicated that it would be necessary for Griffin to secure its supply from Flint River, a small stream about nine miles away. Due to lack of finances the project was not started until the fall of 1929. During June, 1930, the new plant was placed in operation. The river intake is nine miles west of Griffin. A concrete intake, screen chamber and pumping station comprise the buildings and equipment located near the river. The raw water main from the pumping station to the filtration plant consists of 7.8 miles of 20-inch cast iron pipe. The filtration plant is located 1.5 miles from the center of town. The plant is 4 m.g.d. capacity and consists of two 98 by 8 by 16 feet mixing chambers; four 80 by 23 by 12 coagulating basins; four 23 by 18 filters; a 1½ m.g. clear well and the necessary meters, pumping equipment, etc., for making a complete plant. The total cost of the project was $425,000 of which $241,000 was available from the accumulated profits of the water and light plants during the past few years.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Water Supply and Dams in Japan. Allen Hazen. Jour. New England Water Works Assn., **44**: 3, 451, September, 1930. Japan has a large population on a small area, and the land is under a high state of cultivation. Conditions, however, are favorable for the water works business. The central part of the

main island is mountainous and has but little population and produces water of excellent quality and abundant quantity. The larger cities of Japan are grouped around this mountainous area, and none of them are very far from it. The soil of the high mountains seems to be mainly of granite and other hard primitive rocks that yield soft waters entirely free from color and usually free from turbidity. Run-offs are three to three and a half times greater than in New England resulting in high yields. Human excrement being used in Japan as fertilizer, it is not allowed to waste and run over the surface of the ground, so that danger to water supplies is less. Sand filters of high efficiency are in general use and chlorine apparatus stands guard although it is not in use as the filtered water is of such excellent quality. The quality of the water furnished by the Japan cities is well up to the standards of the cities in this country.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

International Register of Spas and Medicinal Waters. Analyst, **56**: 668, 745–747, November, 1931. Standard classification is recommended. Chemical classification should show (*a*) general character, in terms of dominant ions, e.g. chloride, sulphide, sulphate, calcium, ferrous iron, arsenic, etc.; (*b*) ionic concentration in millinormality (N/1000); (*c*) hydrogen-ion concentration, as pH at 20°C. Physical classification should include (*a*) temperature at source (cold, below 20°C.; thermal, 20–37°C.; hyperthermal, above 37°C.); (*b*) radioactivity of water, or of contained gas; (*c*) tonicity (hypotonic, isotonic, or hypertonic, in comparison with body fluids). Medicinal classification, based on analytical data and clinical experience should indicate (*a*) internal action (aperient, diuretic, etc.); (*b*) external action (sedative, stimulant, etc.) Calculate (*a*) bromides, iodides, fluorides, hydro-sulphides (NaHS), phosphates (Na_2HPO_4), and arsenites (Na_2HAsO_3) as sodium salts; (*b*) rubidium, calcium, lithium as chlorides; (*c*) in alkaline water, lithium, strontium, barium, zinc, lead, tin, manganese, aluminum, and iron as hydrocarbonates; (*d*) in acid waters (pH 4), iron and aluminium as sulphates. Remaining major ions are then calculated in following order: anions, NO_3, Cl, SO_4, HCO_3, CO_3, OH; cations, K, Na, Ca, Mg. Results of analysis shall be given in parts per million to one decimal place, or to two, when less than ten p.p.m. are reported; and shall be expressed as ions. Gases shall be determined in cubic centimeters per litre at 0° and 760 mm. Spectroscopic analysis should be made and indicated by "Sp"; ions sought, but not found, shall be indicated. Physical data may include specific gravity (compared with distilled water at 20°), turbidity or colloidal properties, degree of ionization, hydrogen-ion concentration, radioactivity. Climatic data may include temperature, rainfall, atmospheric humidity, prevailing winds.—*W. G. Carey.*

Water Supply Exhibits at the International Hygiene Exhibition, Dresden, 1930. Gas- und Wasserfach, **74**: 20, 450–458, May 16, 1931. Account with fifteen illustrations of exhibits at water supply section of exhibition. References are made to models and charts dealing with operation of waterworks in Germany and to chart of projected scheme of eight lakes on river Ruhr and to their probable effect upon its purity.—*W. G. Carey.*

The Measurement of Water. H. B. MILLARD. Water and Water Engineering, 33: 386, 62–66, February 20, 1931. Positive meters (weight and volume) and inferential meters (current, level, pressure, and velocity) are described. Maximum accuracy in gauging rivers and streams is obtained with Venturi, Pitometer or weir measurements. Venturi meters can be successfully employed in most cases where water is measured in a pipe, or if in open channel, the Venturi flume can be used. Orifice meters are not so generally applicable, because of the greater loss of head owing to the sudden reduction and enlargement of diameter. The Pitometer is of great value in measuring circulating water, or condensate, in power stations and efficiency of turbines and pumps. It is possible in an hour or so to instal a Pitometer and to measure accurately the flow of water without interrupting the service, so that they are of value in investigating distribution from trunk mains. Illustrations and descriptions are given of various types of weir e.g. contracted, suppressed, V-notch, compound, and parabolic.—*W. G. Carey.*

Carbonate Number in Water Analysis. O. MAYER. Zeitschrift für Unterschung der Lebensmittel, 62: 271–291, 1931; Chemistry and Industry, 50: 48, November 27, 1931, B., 1076. Description of rapid analysis based mainly on carbonate number (carbonate hardness expressed as milligrams of calcium oxide per 100 cc. multiplied by 1000 and divided by total solids). Calcite-aggressive carbon dioxide is found from increase of alkalinity of filtered water after 24 hours contact with finely powdered washed marble.—*W. G. Carey.*

Serious Corrosive Processes in Lead and Iron Water Pipes. C. A. H. VON WOLZOGEN-KÜHR. Water en Gas. 6: January 9, 1931; Water and Water Engineering, 33: 389, 240, May 20, 1931. Lead pipes which have lain a few months surrounded with gasworks cinders become pitted and coated with white layer, owing to pieces of unburnt coke forming electric couple with lead as electro-positive element, lead oxide and, later, carbonate, resulting. In corrosion of cast iron pipes by hydrogen sulphide, graphite separates and, forming an electric couple with the iron, intensified corrosive action.—*W. G. Carey.*

An Automatic pH Recorder. C. MORTON. Chemistry and Industry, 50: 48,436–438 T, November 27, 1931. Solution flows through cell, e.m.f. of which fluctuates in unison with pH changes, voltage variation being measured by recording potentiometer. Circuit is similar to usual potentiometric set-up, but slide wire is adjusted automatically and deflection of galvanometer acts as mechanical relay and actuates mechanism which moves slide wire contact, mechanically connected to recording pen. To prevent polarisation cell is made in three compartments separated by porous diaphragms which prevent mechanical mixing of solutions, but not diffusion. Solution under test flows through one side compartment, buffer solution is in other side, and saturated potassium chloride in centre. When quinhydrone electrode used, small bag containing quinhydrone is suspended in special siphon chamber so arranged that contact period is adequate to ensure concentration necessaary—*W. G. Carey.*

The Determination of Manganese. R. G. HARRY. Chemistry and Industry, 50: 48, 434–436 T, November 27, 1931. In bismuthate method, solution must be kept cold and acidity adjusted between 20 and 40 per cent. Endpoint on titration of excess ferrous ammonium sulphate with dichromate is sharp and method is accurate. In bromine oxidation, acidity must be carefully adjusted with calcium carbonate for accurate results; the hydrated peroxide is dissolved in measured excess of standard ferrous ammonium sulphate and excess titrated with permanganate, or dichromate. Persulphate method is essentially identical with bromine method and is given in detail; as also is periodate process. Colorimetric determination by ammonium persulphate necessitates elimination of chlorides.—*W. G. Carey.*

Sanitation and Water Purification. A. PARKER. Annual Report of Society of Chemical Industry on the Progress of Applied Chemistry, 1930, 15: 573–609. Account of recent American, British, and German work on chlorination, superchlorination, and taste-prevention; on treatment with ammonia and chlorine, potassium permanganate, and activated carbon; on sterilization with excess lime, with ultra-violet radiation, and with metals (oligodynamic action) and metallic salts; copious references to original literature being given. Recent droughts and improved sanitation are throwing great burden on water supplies for domestic and industrial processes. Greater attention is being given to treatment of swimming-pool water, and to water for steam-raising. Base-exchange softening is dealt with; experiment show that dissolved metals, e.g. copper, lead, zinc, can be removed, but that bacterial content undergoes no material change. Reference is made to electro-osmotic process for freeing water from salts. Report stresses advantages of activated sludge sewage treatment for partial treatment in combination with trickling filter plant. Recent work discussed comprises sludge digestion, fermentation, and disposal; utilization of sludge gas; effects of temperature, pH value, seeding, two stage digestion, sludge heating, enzymes, colloids, and prechlorination. Section devoted to trade wastes deals with biological filtration, fermentation, and chlorination of beet sugar effluents; with biological purification and benzol extraction of gas works effluents for phenol removal; with activated sludge process for creameries and abattoirs; and with grease removal from wool washings. Formation of river boards, surveys of rivers, measurement of self-purification of streams and importance of dissolved oxygen determinations are also discussed.—*W. G. Carey.*

Preliminary Report of the Copper Pipe Committee (Holland). Water en Gas, 12 and 13, 1931; Water and Water Engineering, 33: 394, 503, September 21, 1931. Amount of copper dissolved from pipes after 16 hours (about 0.003 gram per litre) is not detrimental to health; nor is the amount of arsenic from copper containing arsenic. Hot water dissolved less than cold, and no unpleasant taste is given to cooked food. A very small copper content in food is probably good for health. Tinning of copper pipes is generally done with lead alloy much more dangerous than copper. Use of untinned copper is admissible in almost all cases, but acid water should be neutralized before contact with any metals.—*W. G. Carey.*

Propeller Type Water Turbines. C. S. T. Paul. Water and Water Engineering, 33: 394, 491–496, September 21, 1931. Most widely used turbine has been Francis, or mixed-flow, type, but it is difficult to design high specific speed turbine to operate at high efficiency under fractional load, owing to shock at entry to vanes and owing to eddies in water threads at exit. Development has been to obtain higher speeds together with large runner vane angle by setting back inlet edge of vanes. For specific speeds above 90 revolutions per minute, runners are so placed that flow becomes axial along whole length of runner vanes, these being known as propeller runners. Types of propeller turbines described and illustrated are Gill, Lawaczeck, Moody, Kaplan, and Bell. Various types of draught tube are described, their function in low-head plant being to utilize full effect of head and of elevation of turbine above tail-race level, and also to regain, by suction, a large proportion of discharge velocity from turbine runner.—*W. G. Carey.*

The Field, Status, and Scope of Hydrology. R. E. Horton. Water and Water Engineering, 33: 394, 470–476, September 21, 1931. Hydrology is defined as tracing and explaining the natural circulation of water in, on, and over the earth's surface and may be considered as consisting of two divisions, atmospheric, comprising vapour phase and rainfall, and surface, comprising run-off phase and evaporation. Chart showing principal steps in hydrologic cycle is reproduced and consideration is given to relation of hydrology to physics, hydraulics, meteorology, engineering, and agriculture. Basic data of hydrology dealt with include rainfall, stream flow, evaporation, interception, transpiration, and soil moisture; author pleads for collection of additional data and co-ordination of results.—*W. G. Carey.*

Industrial Water Purification. Anon. Water and Water Engineering, 33: 394, 474–480, September 21, 1931. Hams Hall electricity generating station in Birmingham, England, has installed Lassen-Hjort lime-soda plant, with capacity of 12,000 gallons (Imp.) per hour, for partial softening, after which, water passes through pressure sand filters and finally through Permutit softener. Lime-soda plant has continuous sludge circulation to ensure more complete reaction and hasten precipitation; at intervals sludge is discharged into settling bed and clear water therefrom returned to plant. Air is caused to be entrapped by inrush of water and chemicals and rising air bubbles produce circulatory motion of water. Sand filters and Permutit units have strainer collecting systems to give even draw off of water; a main header pipe with lateral branches fitted with gun-metal strainers. Permutit is regenerated in two stages, first with old brine from preceding regeneration and then with fresh brine. Softened water is 50 percent of feed for Babcock and Willcox boilers operating at 385 pounds pressure and fired by pulverized fuel, remaining 50 percent being condensate.—*W. G. Carey.*

Biological Treatment of Waste Water. O. Mohr. Chemistry and Industry, 50: 22, B, 516, May 29, 1931. In British Patent 343,426 it is stated that efficiency of biological processes using compressed air is increased by introducing into aëration tank a horizontal partition in one or more sections, arranged to

retain air on underside and produce air cushion having pressure equal to combined pressure of atmosphere and hydrostatic head, thus increasing rate of dissolution of oxygen. Surplus air may be released either by using partitions of permeable, or semi-permeable, material, or by pipes discharging in countercurrent to inflow. Aëration chamber utilizing this device may be placed with advantage midway along the settlement channel of a double-storey tank.—*W. G. Carey.*

Hull, England, Water Scheme completed. Anon. The Engineer, **152**: 3954, 425, October 23, 1931. Additional 10 million gallons (Imp.) per day are pumped by two sets of three-throw deep-well pumps each of 5 million gallons (Imp.) per day capacity. Engines, first of their kind used for land purposes, are Brotherhood-Still two-cylinder marine type, using heavy oil, each of 420 brake horse power when running at 300 revolutions per minute. Great economy is expected to result from this type of engine.—*W. G. Carey.*

Carrying a Water Main Across a Bascule Bridge. Anon. The Engineer, **152**: 3947, 244. September 4, 1931. Bascule bridge across Siam river includes water main. At axis of rotation of each bascule leaf is swivel bend in pipe and at centre of span on pressure side is specially designed hydraulic coupling, consisting of cast iron cylinder, gun-metal lined, inside which slides gun-metal pipe fitted at the middle of its length with annular piston. Cylinder is connected to water pressure and sliding member to exhaust, joint between movable pipe and end of main on other leaf of bridge being made by heavy rubber ring pad. Electrically operated sluice valves are situated behind operating cylinder and on the opposite side on land. Electrical controls for coupling and valves are interlocked with those of bridge to ensure correct sequence. Air and water leakage are prevented by special devices. Plan of the arrangement is given and photograph of the coupling and sluice valve.—*W. G. Carey.*

Iodine Supply and the Incidence of Endemic Goiter. J. B. Orr. Special Report of British Medical Research Council No. **154**, 1931. Iodine content of water supplies, eggs, milk, potatoes, cabbages, and sheep thyroid was determined in areas of high and low goiter incidence in England and Scotland. Some indications exist that iodine supply may be lower in goiter areas than in those goiter free; but it is impossible to correlate iodine deficiency in food, or water, and incidence of goiter.—*W. G. Carey.*

The Problem of Chlorine Requirement. Schmidt and Muhlenbach. Gesundheits-Ingenieur, 1931, **54**: 7. Laboratory methods of determining chlorine demand of water were investigated to ascertain if exact data of amount of chlorine required on large scale were obtained thereby. Nikolai's method is influenced by light, samples exposed to diffused daylight having greater ability to combine with chlorine than those kept in dark. Additions of 5 cc. of 0.1 normal alkali, or acid, to 20 cc. of Froboese's hypochlorite solution had no effect; so that standardisation before each titration was unnecessary, and reagent could be regenerated with concentrated eau de Javel, or

chlorine water, the former being preferable for BRUN's method. With water from Königsberg waterworks, consistent results were obtained with the ELMANOWITSCH and ZALESKI, FROBOESE, and NIKOLAI methods, but BRUN's was unsuitable. Methods investigated are still unsuitable for waterworks practice. Greatest importance should be attached to maintaining residual chlorine content of about 0.0001 gram per litre (0.1 p.p.m.) after disinfection.—*W. G. Carey.*

Unusual Case of Pipe Corrosion. Anon. The Engineer, 152: 3955, 463, October 30, 1931. Installation of copper pipes for hot and cold water was satisfactory until supply chlorinated and treated with alumino-ferric, when horizontal copper pipes failed. Trouble was traced to rust settling in pipes and, with treated water, causing electrolytic corrosion. Recommended was, to prevent acidity increase by treatment with sodium carbonate in addition to alumino-ferric, or by substituting sodium aluminate for latter.—*W. G. Carey.*

Water Softening for (English) Railways. Anon. The Engineer, 152: 3957, 507, November 13, 1931. Twenty-eight softening plants are being erected on London, Midland, and Scottish main line. Average hardness is 210 p.p.m. and very substantial economies are anticipated from softening to 60 p.p.m. Consideration was given in special enquiry to respective merits of external and internal treatment, former being favored except where quantity used is so small that capital cost would be prohibitive.—*W. G. Carey.*

Geophysics. Anon. The Engineer, 152: 3942–3946, 112–114, 140–142, 161–163, 200–202, 213–214, July 31, August 7, 14, 21, 28, 1931. Series of five illustrated articles dealing with exploration of underlying strata by observations conducted at surface. Methods chiefly used are (1) magnetic, (2) gravitational, in which very small changes in local gravitational field are measured by torsion balances, (3) electrical, depending on differences in conductivity, and (4) seismic, where differences of seismic effect are recorded when an explosive is detonated. Geophysics should prove valuable to water engineers in determination of bed rock in dam sites, in location of water, and in estimating salinity of such water.—*W. G. Carey.*

The Reduction of Sodium Sulphite by Bacteria and Its Application to Water Examination. W. J. WILSON. British Waterworks Assn. Official Circular, 13: 96, 710–719, October, 1931; Paper read at Brit. W. W. Assn. Annual Meeting, July, 1931. Further experience of WILSON's sulphite-glucose-iron medium in which *B. Welchii* etc. effect reduction of sulphite, producing black iron sulphide, shows it to be of great service in supplementing quantitative *B. coli* test. Medium used is 3 percent nutrient agar, to 100 cc. of which is added, after melting, 10 cc. of 20 percent solution of anhydrous sodium sulphite, 5 cc. of 20 percent glucose solution, and 1 cc. of 8 percent ferrous sulphate solution. Two petri dishes containing 20 cc. of this medium plus 20 cc. of water are incubated for 24 hours at 37°C. and 45°C., respectively. Development on 37° plate of large (5 millimeters) black colonies shows presence of *B. Welchii*, or, not infrequently, of certain types of *B. coli*. Any black colonies are undesira-

ble; large and medium sizes point to contamination. *B. Welchii* grows well at 45°; most other reducing organisms fail to grow on the medium at this temperature. *B. Welchii* is not found apart from fecal pollution, recent or remote, and where two or more are found in 40 cc. of water, supply is suspicious. Tables of results show that reduction test in many instances confirms parallel *B. coli* tests. Author states that grading of well waters is facilitated by test and that it throws light on purity of streams, rivers, etc., while it may add to information afforded by *B. coli* tests. Addition of bismuth to above medium has enabled *B. typhosum* to be isolated from water, on two occasions from river Lagan, showing that bacilli of typhoid group may survive during purification of sewage [cf. J. A. W. W. A., 1930, 1: 136.—ABSTR.].—*W. G. Carey.*

Water Softening Plant at Newton-le-Willows, England. The Engineer, 152: 3955, 471–472, October 30, 1931. Softener designed to treat 234,000 (Imp.) gallons per charge of stream water heavily loaded with organic matter and contaminated with works effluent. Water is brown and hardness varies between 200 and 300 p.p.m. Remarkable clarity is obtained by treatment with caustic soda and sodium aluminate in concrete tank provided with series of steep concrete pyramids at base, each longitudinal and transverse channel so formed being easily cleaned by sludge cocks. Treated water is violently agitated in mixing compartment, then flows along steel channels distributing over whole length of mid-partition reaching nearly to bottom of main tank, in which the water rises at rate not exceeding 1½ inches per minute. Filtration is through coco matting stretched on a series of 40 cast iron grids. Matting at first has little filtering effect, but after about an hour is coated with precipitate and filters bright and clear. After three or four weeks, fresh grids and matting are substituted and used ones dried and beaten. Oscillating bucket proportioning gear is small and is operated by one-tenth of the water measured and discharged by accurately proportioned, sharp-edged, rectangular weir set dead level, remaining nine-tenths flowing over another larger, but otherwise similar, weir direct to mixing compartment.—*W. G. Carey.*

Destruction of Algae and Fungi in Water or Sewage. G. ORNSTEIN. Chemistry and Industry, 50: 18, B., 420, May 1, 1931. Simultaneous addition of chlorine water and copper salt solution is much more effective than either used alone, even when each is added in much greater quantities. Apparatus is claimed in British Patent 340,218 in which proportional doses of the two solutions may be added by siphons at pre-arranged intervals.—*W. G. Carey.*

Determination of Nitrate in Drinking Water. W. MULDER. Pharmaceutisch Weekblad, 68: 995–997; Chemistry and Industry, 50: 48, B., 1076, November 27, 1931. Colour intensity in SCHERINGA's sodium salicylate method is proportional to nitrate concentration and colour is stronger than that given by phenol sulphonic acid. Chloride is added to water and to colorimetric standards to obviate chloride correction factor. Nitrite at high concentration intensifies colour.—*W. G. Carey.*

Some Aspects of Boiler Water Chemistry. H. E. JONES. Chemistry and Industry, 50: 43, 854–858, October 23, 1931. Investigations of HALL and U. S. Bureau of Mines are discussed and author agrees that, even after lime-soda softening, conditioning by sodium carbonate may be necessary to secure separation of calcium as calcium carbonate sludge and prevent deposition of calcium sulphate as adherent scale, formation of calcium and magnesium silicates being also prevented. Above 250 pounds pressure, tri-sodium phosphate is necessary, amount added being slightly more than residual hardness. Sodium aluminate is recommended to quicken softening and reduce residual hardness; little support is given to colloidal theory of scale prevention by organic matter. Description is given of work by PARR and STRAUB on prevention of caustic embrittlement by adjustment of the sodium sulphate: alkalinity ratio. BERL in Germany confirmed PARR that excessive caustic concentration can occur in boiler rivet seams etc., and that embrittlement is prevented by sufficient concentration of sulphate. STRAUB established 100 grams of caustic soda per litre as minimum concentration for embrittlement. Sulphate:alkalinity ratio of 2 to 1 prevents embrittlement at all pressures and recent investigations show that tri-sodium phosphate is even more effective than sulphate for the purpose. Further progress will probably be based on (1) efficient preliminary softening by lime-soda, alkalinity being carefully controlled and residual hardness reduced with sodium aluminate (2) adjustment of relative concentrations of sodium hydroxide, carbonate, and sulphate, in the concentrated water so that dense scale and embrittlement are prevented, and (3) conditioning with phosphate where operating pressure is high.—*W. G. Carey.*

The Cause and Removal of Earthy Tastes in Water. B. A. ADAMS. Water and Water Engineering, 33: 396, 572–574, November 20, 1931. Paper read before Public Works, Roads, and Transport Congress, November, 1931. Actinomyces are primary cause of earthy taste in water, either by their growth in water of high organic content, or by contact of water with soil containing these organisms. All surface soils, except acid ones, yield an earthy taste, which although very persistent and resistant to chemical oxidation, is removed by absorption in chalk, clay, fullers' earth, kieselguhr, kaolin, sawdust, dried peat, or steam-treated soil. Taste, therefore, is often removed by passage of water through lower strata, or by contact with vegetable or mineral debris, either in suspension or in the water course. Earthy tastes were prepared from soil extracts and in all cases were removed by passage of water through various makes of activated carbon; with powdered carbon it was necessary to add rather large amounts to remove completely very strong tastes.—*W. G. Carey.*

A New Method for the Colorimetric Determination of Manganese. R. G. HARRY. Chemistry and Industry, 50: 39, 796, September 25, 1931. Add to hydrochloric acid solution of sample as much pure iron wire (or ferric chloride equivalent) as manganese present, oxidize with nitric acid and evaporate to dryness. Take up with hydrochloric acid, add 14 cc. sulphuric acid (1:1), evaporate to dryness, add 10 cc. 20 per cent sulphuric acid, boil, and dilute to about 250 cc. with water. Heat for 15 minutes with 25 cc. of ammonium

persulphate (25 percent solution), repeat, filter, dissolve manganese dioxide in 10 cc. of hydrochloric acid and make up to 250 cc. with distilled water in graduated flask. To suitable amount of this solution add 1 cc. of tetramethyldiaminodiphenylmethane (0.5 percent in alcohol), 1 cc. strong acetic acid, trace of sodium hydroxide, and finally dilute acetic acid until blue coloration obtained. Match against standard manganese solution similarly treated. Color is reasonably stable (more so than with benzidine), but permanent standards may be made by matching strong standards against crystal violet and weak ones against methylene blue, intermediate colors being obtained by mixtures of these dyes.—*W. G. Carey.*

Two-Mile Intake Improves Potability of Lake Supply. ROBT. B. MILLER. Water Works Eng., **84**: 26, 1779, December 30, 1931. East Chicago and Indiana Harbor, Ind., take their supply from Lake Michigan at point where it is grossly polluted and have recently completed two-mile intake. Tastes and odors were distinct problem against which extensions were planned. Intake well is octagonal with sides from 14 to 16 feet and 38 feet 2 inches deep. Intake pipe, 54-inch, and fittings are fabricated from ⅝-inch steel plate and were furnished in 30-foot lengths, and riveted together at shore to 90-foot sections which were floated to site and connected by divers, using Victaulic joints. Intake consists of two 43-foot lengths of 48-inch pipe, terminating in four inlet drums 10 feet in diameter and 9 feet high, with vertical 1 x 6-inch slats, and chained securely onto pile bents. Connection is made to 54-inch pipe through reducing valve.—*Lewis V. Carpenter.*

Municipal Water Works Obligations. LEO T. PARKER. Water Works Eng., **84**: 25, 1725, December 16, 1931. Courts have held that certificates of indebtedness issued by municipal water department and payable out of water works receipts does not constitute an indebtedness of the city. When private property has sprinkler systems, service charge is legal, even if ordinance provides free water for extinguishing fires. Various courts have held that a city cannot repudiate bonds, even if they are unconstitutional, provided they are in the hands of an innocent third party. A city cannot, except by special authorization, sell a water plant; nor is it, after having obtained such authorization, required to sell, unless it desires to do so. The law is well settled that any person, firm, or corporation, may rescind a contract, if evidence is introduced showing that other party breached the agreement.—*Lewis V. Carpenter.*

Jointing Materials for Cast Iron Pipe. EMIL L. NUEBLING. Water Works Eng., **84**: 25, 1721, December 16, 1931. Author calls attention to wide variation in amount of jointing material for cast iron pipe specified in various publications. Excellent tabulations are made of quantities both of lead and of lead substitute needed, according to manufacturer's literature and handbooks, and including quantities calculated by the author for Mineralead joints.—*Lewis V. Carpenter.*

Fine Anthracite and Sand. M. A. FARREL and H. G. TURNER. Water Works Eng., **84**: 24, 1673, December 2, 1931. Nine experimental filters were

constructed of 4-inch tile drains, 25 inches long, with six inches of gravel and 12 inches either of sand, or of finely divided anthracite. Seven filters were charged with different kinds of anthracite, while the other two were charged with sand. From their very limited experimental data authors conclude that Pennsylvania anthracite shows appreciable advantages over sand as filtering material. These advantages hold promise of settling such important problems as removal of excess chlorine, chlorophenol odors, tastes, turbidity, and color. Superiority is claimed to be due to greater adsorptive and absorbtive abilities of anthracite. Article does not give rate of filtration, or loss of head in filters. —*Lewis V. Carpenter.*

Gas Fired Boilers Furnish Power for San Antonio Pumps. J. B. Nealy. Water Works Eng., **84**: 25, 1721, December 16, 1931. City water supply is taken from 28 wells varying in depth from 900 to 1,300 feet with available capacity of 75,000,000 g.p.d. Average consumption of 47,000 customers is 25 m.g.d., with peaks of 55 m.g.d. Water is pumped at three stations, two of which are steam-turbine-driven centrifugal units and the third a vertical triple-expansion pumping engine. Centrifugals are run at uniform rate, variation in load being taken care of by triple-expansion engine. All three stations use natural gas as fuel.—*Lewis V. Carpenter.*

Shreveport Completes New Water Works Improvement Program. Thom. L. Amiss. Water Works Eng., **84**: 24, 1669, December 2, 1931. In 1920–21, $400,000 was spent on constructing 3-m.g. concrete clear water basin, force main, pump station, and pumping equipment. During 1924–25, work was started on 22-billion gallon storage reservoir, with 225-foot concrete dam and spillway so constructed as to allow excess water in lake to flow to Red River, 3½ miles away. Upward of 4000 acres of land were cleared of all underbrush before allowing water to impound. Two miles of 30-inch lock-joint concrete pipe and one mile of bell and spigot cast-iron pipe bring raw water by gravity to pumping station. Project also included four additional filters of 750,000 g.p.d., complete remodeling of 12 old filters, including all modern controls and hydraulically-operated valves, revamping bottoms, 65,000-gallon elevated wash-water tank, and mixing chamber. Three miles of 24-inch gravity sewer and sewage-lift station were also constructed. Third issue, of $500,000, was placed as mortgage to take care of extensions and of construction of new dual filter plant of 8-m.g.d. capacity. Either this plant, or the old one, alone, takes care of supply for 9 months of year. New plant is very pleasing architecturally and modern in every respect. Filters are uncovered, with operating tables of monel metal and under ceiling of natural pine. Filtered water is delivered under 20-foot head through 100 1¼-inch nozzles into 1-m.g. storage reservoir beneath, becoming aërated as it falls.—*Lewis V. Carpenter.*

Water Supply Conditions in Siam. Walter Buchler. Water Works Eng., **84**: 23, 1607, November 18, 1931. Bangkok, capital of Siam, has only modern water works in the country. Before 1914, this city of 330,000 depended on rain water for their supply and epidemics of intestinal diseases were very prevalent. Water is carried in empty kerosene tins. The late King Chulalongkorn

established numerous fountains where people of Bangkok could get water free. Bathrooms are unknown and people all bathe in the canals (Klongs). Water supply is treated with alum before filtration through mechanical filters and with chlorine gas afterwards. Citizens are not permitted to use city water for bathing.—*Lewis V. Carpenter.*

Milwaukee Installs High Pressure Station for Fire Protection. HERBERT H. BROWN. Water Works Eng., **84**: 22, 1539, November 4, 1931. Station pumps river water into separate high pressure mains. Water is screened by traveling water screen and passes to concrete gallery, 5 by 19 feet, from which the 3 pumps take their supply. Pumps are each of 2,500 g.p.m., are motor driven, and designed to deliver water at 300 pounds pressure. Class H cast iron pipe in distribution system is jointed with Leadite. Power is delivered by two separate 13,200-volt, 60-cycle, 3-phase underground cables. Starting equipment is all automatic, with all valves electrically operated.—*Lewis V. Carpenter.*

The Ownership of Water Rights. LEO. T. PARKER. Water Works Eng., **84**: 22, 1543, November 4, 1931. Supreme court ruled that State of New York was entitled to take 440,000,000 gallons of water daily from the part of the Delaware River within state boundary. The decision held that neither state was entitled to the full use of the water. Legally a stream is a natural flow of water. The fact that it dries up in summer does not alter this definition. Courts have upheld this decision. Land owner has only the reasonable use of percolating waters on his land in some states, while others grant him all of it. One case is cited where court states that once these waters become part of a flowing stream, this absolute ownership ceases and land owner is entitled only to reasonable use of the water. Right to maintain a dam is upheld; but if owner of dam fails to use any of the water for an unreasonable length of time, he may be compelled to release the impounded water. In another case, the Tujunga Water Company was granted certain government lands for construction of a dam. When they failed to build it, the land reverted to the government.—*Lewis V. Carpenter.*

Special Lining of Pipe. ALEXANDER POTTER. Water Works Eng., **84**: 22, 1545, November 4, 1931. Economic life of cast iron mains must obviously be based, not upon the longevity of cast iron pipe, but upon assumed carrying capacity of the pipe for economic design period. Contract was let for 25 miles of centrifugally-spun pipe with bituminous lining. Writer feels that they will get coefficient, C, of 161.2, as compared with 145 to 150 for cement lined. This bituminous material after 13 years was found to be in perfect condition. System for the Parsippany-Troy Hills system was designed for a C of 120 and this value removed the necessity in several cases, of going to next larger diameter. Saving of $0.11 per foot was effected by using lined pipe. Sodium carbonate, which was used as flux in manufacture of the pipe, had to be thoroughly removed before applying lining. After pipe was dry, thin priming coat of coal tar was applied on inside surface. Bituminous enamel is applied hot from a trough inside the pipe while it is being revolved horizontally. Enamel dries in about one minute.—*Lewis V. Carpenter.*

Progressive Water Works Enlargement at Racine, Wis. DONALD H. MAXWELL. Water Works and Sewerage, **78**: 129–132, 1931. By expending an average of $125,000 over period of twelve years, water works system improvements have been financed entirely by earnings. Present equipment includes 36-inch intake, low-lift pumps, filter plant, high-lift pumps, and 2,750,000 gallon standpipe. Proposed additions include new pumping station, suction well, tunnel intake connection, filter addition, and service building.—*C. C. Ruchhoft.*

Effect of Drought on Quality of Water at Charleston, W. Va. G. D. NORCOM. Water Works and Sewerage, **78**: 199–201, 1931. Due to low stream flow and addition of sewage and garbage to the Elk River, source of water supply became grossly polluted. To remove tastes and odors, aëration system was installed. Activated carbon and super-chlorination and dechlorination were not found very effective in removing tastes and odors. Pre-chlorination alone gave best results.—*C. C. Ruchhoft (Courtesy Chem. Abst.).*

How Bacteria are Killed by Disinfectants. JOHN R. BAYLIS. Water Works and Sewerage, **78**: 193–5, 1931. Disinfectants coagulate the colloids in the cell to destroy it. It is possible under certain conditions to peptize the coagulated protoplasm and bring the cell back to life again. BANCROFT and RICHTER point out that testing of disinfectants should be studied from point of view of reversibility of coagulation produced by the disinfectant rather than by determination of growth, on relatively inert media, after exposure. It is perhaps desirable that longer contact periods with disinfectants be used.—*C. C. Ruchhoft.*

Training of Water and Sewage Plant Operators. ISADOR W. MENDELSOHN. Public Works, **62**: 1, 57–8, 1931. Discussion of efforts made by various organizations such as State Boards of Health, American Society of Civil Engineers, and American Water Works Association toward improved operation of water and sewage works.—*C. C. Ruchhoft (Courtesy Chem. Abst.).*

Water Softening and Purification Plant of Dundee, Mich. Water Works and Sewerage, **78**: 45–7, 1931. Complete description of softening and purification plant having capacity of 600,000 gallons per day. Treatment includes carbonation and adsorption of tastes and odors with activated carbon.—*C. C. Ruchhoft (Courtesy Chem. Abst.).*

New Wells, Pumps, and Storage for Water Works System of Scotia, New York. HENRY W. TAYLOR. Public Works, **62**: 4, 26–7, 1931. Increased well capacity was obtained by installing open, steel-sheeted well, 10 by 15 feet in plan and 50 feet deep. New low-level pumps were installed which discharge well water into low-level reservoir of 500,000 gallons, sufficient for one day's supply. Three high duty pumps are fed from low-level reservoir and can be operated at any desired rate without necessitating rapid pumping of wells.—*C. C. Ruchhoft.*

The Diesel Engine in Municipal Plants. C. F. LAMBERT. Water Works and Sewerage, 78: 240–2, 1931. Data are presented to aid in selecting an efficient, small size, power plant.—*C. C. Ruchhoft.*

Resanding the Filters at the Water Purification Plant of Cincinnati. CLARENCE BAHLMAN. Water Works and Sewerage, 78: 236–9, 1931. Old sand was removed by means of sand ejector. New dry-screened Ohio river sand, having average effective size of 0.37 mm. and uniformity coefficient of 1.46, was laid in place by same means. Data on screening and on costs are included.—*C. C. Ruchhoft.*

Real Progress Being Made in Treatment of Water to Prevent Corrosion. JOHN R. BAYLIS. Water Works and Sewerage, 78: 217–221, 250–254, 1931. B. reviews literature on this subject and gives several examples of treatment for corrosion. Originally, object of using lime in water supplies was to eliminate red water troubles. Recent investigations have shown the economy of depositing a protective film of calcium carbonate on interior pipe surfaces. Indications are that pipe coatings such as cement and tar are not permanently effective unless film of carbonate is deposited upon them. In general it may be said that hard waters just saturated with calcium carbonate possess the most desirable equilibrium. Waters having calcium carbonate alkalinity below 30 p.p.m. should be slightly supersaturated, but not enough to produce a caustic water. Presence of magnesium carbonate, or of sodium carbonate, may alter the equilibrium curve. Bibliography is appended.—*C. C. Ruchhoft.*

Prepare for Algae Troubles. JOHN R. BAYLIS. Water Works and Sewerage, 78: 114–20, 1931. Tastes and odors, with attending interference with filter operation, caused by algae growths, may be minimized by careful control of water supplies. Source of raw water is important, since supplies from rivers and small streams give least trouble in this respect. Reservoirs holding more than one day's supply have greater tendency to support algae growth. Covering reservoirs holding less than two days' supply is considered an economical procedure to prevent growth of algae. Impounding reservoirs should possess a minimum of shallow areas along shore line. For treating large reservoirs and waters high in organic content, copper sulfate is preferred. Small reservoirs are best treated with chlorine, or, if chlorinous tastes are produced, with chlorine and ammonia. Severe cases of algae troubles are best eliminated by use of chlorine, since large doses may be applied without danger to health.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Operation of Wanaque Reservoir of North Jersey Water Supply District. ATTMORE E. GRIFFIN. Water Works and Sewerage, 78: 222–4, 1931. *Chlorination.* Vacuum type chlorinators maintain 0.10 p.p.m. residual after 30-minute contact. Manganese present in water would often, if not corrected for, give false residual chlorine values. Chlorination not only sterilizes, but also neutralizes tastes due to algae growths. *Application of lime.* Two dry-feed machines located 1900 feet below conduit intake apply from 4 to 15 p.p.m. of lime to mixing and equalizing tank. Installation of automatic

pH recorder and lime dose adjuster, to maintain a pH of 8.0, is planned for near future. *Algae Control.* During early September, when algae growths are at maximum, surface water is treated with copper sulfate. Coves and lagoons are also treated. *Sanitation Control.* Reservoir is constantly patrolled. Bathing is allowed in tributary waters, but not in reservoir. Fishing is prohibited and this ruling is strictly enforced.—*C. C. Ruchhoft.*

Use of the Pitot Tube and Manometer or Recorder in Making Water Flow and Pressure Studies. HUBERT B. SMITH. Journ. New Eng. W. W. Assoc., **44**: 4, 471–78, December, 1930. Condition of distribution system is often the real answer to question of adequate supply and pressure. Frequent surveys will enable operator to meet new conditions engendered by shifting centers of population and influx of industries and to maintain pressure to meet maximum consumption and fire demand. Instruments needed are pitot tube, pressure gauge, and leak locating devices. Pitot tube may be inserted through 1-inch corporation cock and fitted with indicating manometer arranged to furnish continuous record of velocities in pipe. Range of 0.5 to 11 feet per second is usually sufficient. Inadequate metering is a hazard. It may result in lack of water, under-chlorination, and capital expense which might have been avoided. Public Service Commissions have penalized water companies on rates where losses were excessive.—*T. F. Donahue.*

The Submarine Pipe Line Between Portland, Me., and Great Diamond Island. HARRY N. FULLER. Journ. New Eng. W. W. Assoc., **44**: 4, 479–84, December, 1930. Portland Water District took over task of supplying water to Mackworth's Island and to Great Diamond Island, on which Fort McKinley is located, after 8-inch line between the islands, laid by Government at great expense, leaked so badly that it had to be abandoned. Out of 5300 feet of this pipe salvaged, 800 feet were used in reconstructed line. Crossing of river mouth, where depth of 30 feet was encountered, was accomplished on pile and cap foundation. For remainder, submarine trench five feet deep, 5 feet wide at bottom and 10 feet at top, was dug and pipe-laying chute, or giraffe, utilized. Entire job, including 1700 feet of 12-inch pipe on mainland and Mackworth's Island and 6800 feet of 8-inch pipe to Great Diamond Island was completed in 100 working days. Cost of 8-inch submarine line installed was $10.30 per foot. Pressure test on completion showed remarkably small loss.—*T. F. Donahue.*

Copper and Health. WILLIAM G. SCHNEIDER. Journ. New Eng. W. W. Assoc., **44**: 4, 485–94, December, 1930. Recent investigations confirm PASTEUR's observation that it is impossible to take enough copper into the human system to be fatal. Small amounts are harmless. An adult may take 500 mg. per day without deleterious results. Some foods are high in this mineral, oysters containing 2000 mg. per kg. There is no systemic poisoning, as copper is normally present in the body. FLINN and VAN GLAHN of Columbia refuted MALLORY's contention that chronic copper poisoning causes cirrhosis of the liver (hemochromatosis) by proving that livers of copper workers have a minimum of copper, which is normally eliminated in the stool. They also

found it impossible to produce cirrhosis in rabbits with copper. Recent experiments indicate that copper may act as a catalyzer in making iron available for hemoglobin, thereby explaining beneficial effects of liver in diet for treating anemia. In general, the relatively low copper content of water after passing through copper or brass pipes is not injurious and may be beneficial. Water containing more than 5 p.p.m. of copper would be so nauseating as to be unfit for consumption.—*T. F. Donahue.*

How Small Cast Iron Pipe is Made and Used. J. R. McWane. Journ. New Eng. W. W. Assoc., **44**: 4, 495–98, December, 1930. Unearthing of ¾-inch cast iron threaded pipe at Louisville, in good condition after 50 years service, forecasts possible return to favor of cast iron for small pipes. Originally, pipes were cast horizontal with dry sand core and one or more chaplets to keep core central. The vertical method used for larger sizes is not practical for small pipe. A. W. W. A. specification that pipe must be cast vertical in dry sand molds does not necessarily mean that there is a virtue *per se* in dry sand. Use of green sand causes more sudden cooling than with dry sand and a closer grain casting, strong and machinable. In 2-inch size, pipes are 5 or 6 feet long, assembled at plant in 15-foot and in 18-foot lengths. Standard Briggs thread is used and pipes are threaded for next larger size to make possible a heavier wall at base. The 2-inch and 3-inch sizes are popular for services in golf irrigation projects. Cast iron is also coming into favor for gas lines where a pressure of 10 to 30 pounds is carried.—*T. F. Donahue.*

Hydraulic Service Characteristics of Small Metallic Pipes. G. M. Fair, M. C. Whipple, and C. Y. Hsiao. Journ. New Eng. W. W. Assoc., **44**: 4, 499–532, December, 1930. Comprehensive and carefully controlled experiment over three year period was undertaken at Harvard Engineering School to determine hydraulic service characteristics of small pipes of copper, red brass, admiralty metal, galvanized wrought iron, galvanized steel, wrought iron, and steel. Parallel lengths of 100 feet were set up in ¾-inch and 1¼-inch sizes for cold water and in ¾-inch size for hot water. Hydraulic service characteristic was measured in terms of Hazen-Williams coefficient, C_w. Copper, red brass, and admiralty metal possessed hydraulic properties yielding no appreciable deterioration after delivery of 1 million cubic feet. Galvanized steel and galvanized wrought iron, with slightly lower initial capacities, showed only slight reduction. Steel and wrought iron, starting much lower than copper, deteriorated rapidly, showing but one-half the capacity of copper after discharging 200,000 cubic feet of water. After passing 500,000 cubic feet, the 1¼ inch size was equivalent to 1-inch pipe. With hot water, effects were more marked, protective coatings of galvanized pipes failing to stand up, while tubercles in steel and wrought iron pipes almost clogged them. In passing through copper pipe, drop in dissolved oxygen, as determined by Winkler's method, was also relatively low; figures for ¾-inch and 1¼-inch pipes being 0.16 and 0.08, as compared to 0.54 and 0.33 for wrought iron.—*T. F. Donahue.*

Methods Attempted for the Prevention of Phenol and Other Tastes in the Water Supply at Rahway, N. J. Mortimer M. Gibbons. Journ. New Eng.

W. W. Assoc., 45: 1, 6–14, March, 1931. City of Rahway obtains its supply from Rahway River which rises in the Oranges and empties into Arthur Kill. Watershed of 40 square miles contains 40 factories and has population of over 1000 to the square mile. Water is of moderate turbidity, hardness, and color. In attempt to eliminate medicinal tastes, offending plant was forced to install process for recovering phenol; but taste persisted and biologic activity of stream was retarded. Experimentation with superchlorination followed by dechlorination after two hours with SO_2 failed to eradicate medicinal taste even when as high as 10 p.p.m. of chlorine was used. Woody taste was reduced, but musty quality added. Laboratory tests on filtered water, adding ammonia fifteen minutes before the chlorine, resulted in only slight reduction of taste. Potassium permanganate, used on plant scale, with dosage varying from 0.65 to 1.43 p.p.m., added at coagulation basin 6 hours before filtration, was likewise ineffective, although it did decrease fishy taste due to *Synura*. Two-foot bed of activated carbon, sixteen inches in diameter, eliminated medicinal quality with rates of flow up to 4 gallons per square foot per minute, but left the water tasting flat and woody. Activated carbon was not successful with another waste; mash and fermenting wastes from distilleries impart to water musty odor of decomposition varying somewhat according to varieties of yeast and bacteria present. While activated carbon alone failed to remove mustiness, it is believed that with superchlorination it will be effective. In addition to wastes contaning phenol, alcohol, aniline, organic solvents, and chlorine, molasses from illicit distillery in abandoned factory added to burden of supplying a potable water, causing water at the tap to be foamy, sickly sweet, and undrinkable, with color of 200 p.p.m. and the oxygen consumed of 70; the sweet odor persisting through filtration and double aëration. Coöperation of Federal Agents was enlisted to stop this discharge; but adequate protection against industrial pollution is not available. With aid of State Board of Health, action is being taken against plant discharging phenol and aniline.—*T. F. Donahue.*

Disinfection of the Wanaque Aqueduct. Attmore E. Griffin. Journ. New Eng. W. W. Assoc., 45: 1, 1–5, March, 1931. Method of disinfecting Wanaque Aqueduct, supplying water to several cities in north metropolitan area of New Jersey, was by means of liquid chlorine applied at 8 p.p.m. dosage. Time to travel the 20.5 miles was in excess of five days; a day's retention period was added; and lines were then flushed with water having normal dosage of 0.35 p.p.m. On forty samples collected, highest 37.5°C. count was 5, with not a single plate showing *B. coli*. Chlorine demand was 0.10, increasing later to 0.30. The remarkable results were in part due to extreme care taken in laying the pipes.—*T. F. Donahue.*

Pollution of Reservoirs by Gulls and Other Birds. G. C. Houser. Journ. New Eng. W. W. Assoc., 45: 1, 15–20, March, 1931. In 1931 Massachusetts passed a bill legalizing shooting of gulls over reservoirs. Trouble with gulls and pigeons is widespread. In Los Angeles, 10,000 gulls rest on a reservoir at night. Metropolitan Water Board of London estimates that each gull contributes 50 to 100 million *B. coli* per day to a reservoir, while B. A. Adams

isolated *B. typhosus* from gulls' excreta following occurrence of typhoid epidemic in England. Besides public health significance, there is considerable objection to presence of gulls from aesthetic viewpoint, leading many municipalities to consider inclosed reservoirs.—*T. F. Donahue.*

Water Waste Prevention. DAVID A. HEFFERNAN. Journ. New Eng. W. W. Assoc., **45**: 1, 21–22, March, 1931. Water consumption of Milton, Mass., has been held to minimum through 100 per cent metering and frequent inspections. Investigators make considerable use of aquaphone, leak detector, and geophone. Per capita rate is 54 gallons per day, with 79 percent of water pumped accounted for.—*T. F. I onahue.*

Breaks in Water Mains, Service Pipes, and Hydrants. A Symposium. Journ. New Eng. W. W. Assoc., **45**: 1, 23–65, March, 1931. **General Statement.** FRANK A. MCINNES. 23–27. Greatest offender among causes for breaks in cast iron pipes is rigid bearing, a solid foundation, as a rock, which holds up part of the pipe from settling with the rest. Other causes are adjacent excavations, water hammer, electrolysis, lightning, frost, blasting, bad ground, and character of the pipe. Earthquakes are unimportant in New England. **Experience in Metropolitan Boston.** SAMUEL E. KILLAM. 28–29. Writer lists the 21 breaks in cast iron mains from 1917 to 1929, inclusive, with size, location, date of occurrence, reported cause, and pertinent comments. **Experiences in New Bedford.** STEPHEN H. TAYLOR. 30–34. Wrought iron cement-lined pipe installed in 1869 was found in precarious condition in 1880. A 48-inch steel main $\frac{5}{16}$ inch thick, in service since 1899, is now badly pitted and will give trouble. A number of major leaks are listed. **Experience at Quincy and Revere.** FRANK A. MARSTON. 35–38. There have been no unexplained leaks in 3 miles of sand cast pipe, whereas there have been 12 leaks in 15 miles of centrifugally cast pipe, exact causes for which are unknown, although possibly greater brittleness and incipient cracks may have been contributing factors. **Classification of Major Interruptions.** CHARLES W. MOWRY. 39. Of 405 major interruptions to water service investigated, 233, or more than half, were due to failures in distribution system. **Service Pipes.** GEORGE H. FINNERAN. 40–43. After listing factors influencing interruption in service to domestic users in Boston, writer selects for discussion electrolysis and water hammer. **Thawing Frozen Water Pipes.** GEORGE H. FINNERAN. 44–53. Very interesting account of severe weather of December, 1917, when 2633 service pipes, 6720 feet of main pipes, 479 hydrants, and 6812 meters were frozen. Twelve boilers, 5 storage batteries, and 8 overhead electrical outfits were in use for thawing purposes. **Experience with Water Mains and Cement-Lined Pipe at Danvers, Mass.** ROGER W. ESTY. 54–65. Writer favors use of protective lining of cement at least $\frac{3}{16}$ inch thick in cast iron pipe. Complaints from consumers receiving water from dead ends of a soapy, limy taste may be eliminated by installing faucet on the blow-off.—*T. F. Donahue.*

The Atlantic City Water Works. LINCOLN W. VAN GILDER. Journ. New Eng. W. W. Assoc., **45**: 1, 66–71, March, 1931. Water Works system of popu-

lar New Jersey resort has kept pace with growth of community. In 1880 franchise was given to R. D. Wood and Co., operating as Atlantic City Water Co., to furnish surface water to population of 5,500. Second franchise was issued in 1888 to citizens forming the Consumers Water Co., to supply water from artesian wells. Later the two franchises were consolidated and, in 1895, purchased by the city. Present system dates from fire of December, 1909, which put the Absecon P. S. out of service. New building was erected and old stave supply main replaced with cast iron. In 1925, artesian well 675 feet deep was bored and pumped, supplementing supply from Absecon Creek. While present equipment is sufficient for present maximum demand of 22 m.g.d., with 30 m.g.d. as peak load, future expansion is planned which will necessitate purchase of 25-m.g.d. centrifugal service pump and installation of another 48-inch cast iron force main. At rate of 12 cents per 1000 gallons, water system is self-supporting.—*T. F. Donahue.*

Water Hammer in Pipe Lines. Its Causes, Manner and Action, and Effects. H. K. BARROWS. Journ. New Eng. W. W. Assoc., **45**: 1, 72–85, March, 1931. Simplified account of Prof. N. JOUKOVSKY's experiments and studies at Moscow Water Works (1897–98), as translated and amplified by Miss OLGA SIMIN for publication in the Journ. A. W. W. A., **1904**: pp. 341–428. In using JOUKOVSKY's results to find air-pockets and leaks in pipes, the drop in the pressure line is at a distance corresponding to double the distance between gate and point of leakage. More recently, N. R. GIBSON has made use of the water hammer phenomenon in developing a method of measuring flow in penstocks of power developments, based upon plottings of time against pressure-change following turbine gate closure. The method, though little used, is apparently accurate.—*T. F. Donahue.*

Directory and Analysis of Central Electric Stations in Canada. Water Resources Paper No. **55**, 1929. Dom. Water Power and Reclamation Service, Dept. of Interior, Ottawa. Directory and statistics of stations to May 1, 1928.—*M. H. McCrady.*

Annual Report 1927–28, Dominion Water Power and Reclamation Service. Dept. of Interior, Ottawa. Total hydraulic installation to end of 1928 will be more than 5,100,000 h.p. Total resources for the Dominion, are indicated to be over 20,000,000 h.p. under conditions of minimum flow, or over 33,000,000 h.p. ordinarily available for 6 months of year. In 7 years, total installation in Canada has been doubled. Present installation effects saving of 28,500,000 tons of coal per annum.—*M. H. McCrady.*

St. Lawrence and Southern Hudson Bay Drainage. Water Resources Paper No. **58**, 1929. Dom. Water Power and Reclamation Service, Dept. of Interior, Ottawa. Hydrometric investigations in Ontario and Quebec, for climatic years ended September 30, 1926 and 1927.—*M. H. McCrady.*

Pacific Drainage. Water Resources Paper No. **59**, 1929. Dom. Water Power and Reclamation Service, Dept. of Interior, Ottawa. Hydrometric

investigations in British Columbia and Yukon Territory for climatic year ended September 30, 1927.—*M. H. McCrady.*

Water Powers of Canada. Water Resources Paper No. **60**, 1927. Dom. Water Power and Reclamation Service, Dept. of Interior, Ottawa. General review of development of water power in the Dominion, review by Provinces, and section on investigation and administration, with special reference to legislation in the various Provinces.—*M. H. McCrady.*

Pacific Drainage. Water Resources Paper No. **61**, 1930. Dom. Water Power and Reclamation Service, Dept. of Interior, Ottawa. Hydrometric investigations in British Columbia for climatic year ended September 30, 1928. —*M. H. McCrady.*

Arctic and Western Hudson Bay Drainage. Water Resources Paper No. **62**, 1930. Dom. Water Power and Reclamation Service, Dept. of Interior, Ottawa. Hydrometric investigations in Alberta, Saskatchewan, Manitoba, and Ontario for climatic year ended September 30, 1928.—*M. H. McCrady.*

Atlantic Drainage. Water Resources Paper No. **63**, Dom. Water Power and Reclamation Service, Dept. of Interior, Ottawa. Hydrometric investigations in Nova Scotia, New Brunswick, and Prince Edward Island for the 2-year period ended September 30, 1928.—*M. H. McCrady.*

Irrigation Practice and Water Requirements for Crops in Alberta. Irrigation Series, Bulletin No. **7**, 1930. Dom. Water Power and Reclamation Service, Dept of Interior, Ottawa. Revised edition of Bull. No. **6**.—*M. H. McCrady.*

Controlling River Pollution. Anon. Municipal Sanitation, 3: 3, 107. Watershed of Upper Potomac River and tributaries is described and cities thereon listed. Variable conditions as to quality and quantity of Potomac River water caused various riparian manufacturers to approach the Maryland State Board of Health with complaints and asking suggestions for relief. The Izaak Walton League demanded better conditions for fish life. After friendly conference between State Board of Health and major manufacturing concerns on Maryland side, ABEL WOLMAN, Chief Engineer of State Health Department organized the Upper Potomac River Board, October 30, 1929, comprising West Virginia Pulp and Paper Co. at Luke, Celanese Corporation of America at Amcelle, Kelly-Springfield Tire Co., Potomac Edison Co., and City of Cumberland, Maryland. Program outlined included co-operation by U. S. Geological Survey in construction of gauging stations. Board has agreed to a 5-year plan for carrying on work, when it is hoped the State will continue the program. Analytical determinations prescribed by Mr. WOLMAN are: total solids, volatile solids, sulphates, chlorides, iron, hardness, alkalinity, pH value, turbidity, color, dissolved oxygen, and B. O. D. Each of above-mentioned concerns has reported their analyses to State Board of Health at Baltimore where they are recorded and summarized in chart form. Results follow: *West Virginia Pulp and Paper Co.—Luke Plant.* In 1930, educational

campaign among plant employees resulted in marked reduction in chemical loss and in suspended solids discharged. Object was to improve process conditions in order to retain materials of value, or which might be harmful to the stream, and release only those not disposable in any other manner. Weekly analyses of the river water below the mill proved that these changes had been effective in reducing amount and character of load on the river, in spite of sub-normal stream flow. *Celanese Corporation of America.* This plant, 25 miles below Luke, needs water low in color, in suspended material, and in mineral content. Previous troubles included (1) too much alum needed to remove color and turbidity, (2) costliness of this treatment, (3) matting of fibers on pressure filter beds, (4) impossible to decolorize and clarify the water sufficiently. Improvements, or more favorable conditions, were noted by September, 1931. *Kelly Springfield Tire Co.* reports that year 1930 was especially trying with reference to boiler feed water, due to high concentration of incrustants and of foam-making materials. Confidence is expressed that troubles were minimized by controlling influence of the Upper Potomac River Board. *Potomac Edison Company* has hopes of soon using the water for cooling purposes without pretreatment. *City of Cumberland* is not materially affected by the Potomac River, except from aesthetic point of view, as its municipal supply is taken from Lake Gordon, 9 miles north in Pennsylvania. The Board suggests a more uniform flow of the Potomac River, to be accomplished by series of dams to serve as flood control and increase the quality and the volume of water to meet present and future demands.—*R. E. Noble.*

NEW BOOKS

British Waterworks Year Book 1930–31. Third Edition. 422 pp. Published by British Waterworks Association, 173 Roseberry Avenue, London, E. C. 1. Price 21 shillings. Directory of 871 British Water Undertakings, giving for each, date of establishment, limits and area of supply, sources and character of water, reservoirs, fuel consumed, domestic, miscellaneous, and meter charges, bulk supplies, water fittings accepted. Statistical tables include sources of supply, type of filtration and distribution, average daily quantity, population, analysis of accounts, charges for residential property, shops and offices, public purposes, and for bulk and metered supplies. Volume concludes with 40 pages of information on waterworks associations, advisory committees, etc.—*W. G. Carey.*

A Simple Method of Water Analysis with Sections on the Analysis of Sewage Effluents and on the Purification of Water by Means of Chlorine: Especially Intended for the Use of Medical Officers of Health, Sewage Works Managers, and Other Sanitary Officials. J. C. Thresh and J. F. Beale. Tenth Edition, 1931. London. From Bulletin of Hygiene, **6**: 9, 729, September, 1931. Contents are well indicated in the title. Its usefulness is responsible for its wide popularity. This new edition has been carefully revised and brought up to date.—*Arthur P. Miller.*

Rand Water Board Annual Report. Anon. The Engineer, 152: 3946, 224–225, August 28, 1931. Report for year ending March 31, 1931 states that population of 674,886 is served by Vaal River impounding reservoir, two sets of bore holes in Klip River Valley, and wells at Zuurbekom. Water raised was 6,447 million gallons (Imp.), an increase from previous year of 556 million gallons (Imp.). Consumption by mines shows sharp upward tendency; by railways, slight fall. Vaal river water is filtered and chlorinated and, from 306 chemical and 511 bacteriological examinations, is found to be consistently good. Pipe lines are principally of welded and riveted steel, but reinforced concrete pipes manufactured locally are coming into use. Coal delivered during year totaled 80,365 tons, at average cost of 106.71 pence per ton delivered at bunkers. Cost of pumping and purifying water was 6.404 pence per 1,000 gallons.—*W. G. Carey.*

Eleventh Annual Report of Ohio Conference on Water Purification, October 15–16, 1931. 94 pp. **Special Design Recommended for Influent Line to Filters at Softening Plants.** 25. One item which should be considered in designing lime-soda water softening plants is accessibility for cleaning purposes of pipe line from settling basins to filters. Considerable incrustation occurs, even when carbonation is practised. At larger plants these lines are usually large enough to permit removal of incrustation by hand-chipping. Suggested that such lines be made as short as possible and that crosses be employed instead of elbows and flanged, rather than leaded, joints. **Hangers Built Into the Ceiling of the Pipe Gallery for Convenience in Handling Valves and Fittings.** 25. Hangers of reinforcing-iron built into ceiling of pipe gallery during construction of addition to filter plant at Bucyrus have proved very useful in handling valves and making changes in piping. **Comparison of Turbidity Determination Methods.** WILLIAM I. VAN ARNUM. 25. Turbidities of 3 samples of wash water were found to measure 43 and 44 per cent less (200 as against 350 p.p.m. and 240 as against 425 p.p.m.) by candle turbidimeter than by platinum wire method. Turbidities of water containing precipitated chemicals measuring 100 by fullers' earth standards have shown approximately same percentage error with candle turbidimeter, although the 100 fullers' earth standard itself reads 100 in the turbidimeter. **Bad Tastes Caused by Sand Shrinkage and Algae in the Filtered Water at Akron.** J. S. GETTRUST. 26. Algae passing through shrinkage cracks along walls of filters led to development of objectionable tastes in dead ends of Akron distribution system last summer. Principal form in raw water was *Coelosphaerium*, which was present to extent of 10,000 standard units per cc. Examination showed same organisms present in mains, in areas from which complaints were received, as were prevalent in raw water. To remedy this condition, filters were washed when loss of head reached 3 to 4 feet, alum dosage was increased, prechlorination was adopted, and wash water rate was increased from 21 to 26 inches rise per minute. Since October 1, filters have been kept in service until loss of head reaches 7 feet. On a previous occasion when sand shrinkage occurred, loss of head would increase to 5 feet and then remain stationary. It is planned to fasten a brass angle around filter walls about 6 inches below sand surface. **Proof of the Effectiveness of Ammonia-Chlorine Treatment in**

Preventing Phenol Tastes. CLARENCE BAHLMAN. 27. Rain water draining from freshly-laid, tarred roofing felt into filters resulted in intense chemical taste in tap water in Cincinnati, differing but very slightly from ordinary chlor-phenol taste. Application of 1.3 pounds of ammonia per million gallons to filter effluent, prior to chlorine dosage of 1.75 pounds, completely prevented development of taste following a second rain shortly after. Roof drains to filters have since been removed. Laboratory tests showed that water from roof, three months after repairs had been completed, developed taste when chlorinated. Subsequent experiments have led to application of 1 pound of ammonia and 3.25 pounds of chlorine per million gallons as routine treatment. In discussion (p. 9) it was reported that tastes due to drainage from freshly tarred roofs had also occurred at Lima and Medina. **Studies in the Comparative Value of Three Different Media in Routine Bacteriological Water Analysis.** ROSEMARY BOLE, 28–30. Results of two series of comparative tests on well and spring waters with standard lactose broth and modified broth (3.57 grams oxgall added per liter of standard lactose broth, cf. GETTRUST and HOSTETTLER THIS J., 23: 1641) and with standard lactose broth and brilliant green bile (Difco 2 per cent special), respectively, are summarised and discussed. Positive presumptive tubes were confirmed by streaking on eosin methylene blue agar and transferring typical colonies to lactose broth. Coli and aërogenes differentiation was made from colony appearance only. Methyl red, Voges-Proskauer, and Koser reactions were used in doubtful cases. Results were as follows:

	Standard Broth	*Bile Broth*
Coli-aërogenes completions	910	853
B. coli completions	329	395
B. aërogenes completions	581	458
	Standard Broth	*Brilliant Green Bile*
Coli-aërogenes completions	1366	1307
B. coli completions	738	786
B. aërogenes completions	628	521

The percentage of presumptive positive tubes confirmed as containing coli-aërogenes organisms were as follows: standard broth 94.8; bile broth 96.6; brilliant green bile 98.7. The results indicate that the inhibitory effect of the bile media is confined to the aërogenes group, *B. coli* completions being increased. Parallel use of lactose broth and one or other of the bile media gave nearly 100 per cent completion when gas was present in both media employed. Considering both series as a whole, there were 6 per cent of the total completions by all methods which did not ferment lactose broth and 12 per cent which did not ferment one or other of the bile media. A review of literature indicates that a combination of bile and dye in optimum concentration is, up to present time, the best, even though an incomplete answer to problem of selective media in water analysis. **Suggested Changes in Presumptive B. Coli Tests. A Report of Committee on Standard Methods.** J. S. GETTRUST and C. C. HOSTETTLER. 31–4. Comparative tests were made with standard lactose broth and modified broth (see above) at 5 plants during the year. Results obtained are summarised and discussed. While conflicting reports were

received, the data submitted indicate that modified broth has virtues not possessed by standard medium. It inhibits most of false presumptives encountered in filtered and chlorinated waters, but is not 100 per cent perfect in this respect. Tests on raw waters in most cases showed more gas formers and more confirmed *B. coli* with modified broth than with standard broth. In discussion it was stated that organisms causing spurious fermentations in lactose broth at Fostoria survived a 4-hour detention period in presence of 50 p.p.m. causticity, as employed in the softening process. In Kansas, a broth medium containing fuchsin has been found to eliminate to large extent gas formers which do not confirm as *B. coli*. In view of fact that next edition of Standard Methods will recommend use of brilliant green bile in parallel with lactose broth for unfinished waters, it was decided to substitute brilliant green bile for modified broth in future studies. **Comparison of "Modified Bile" Broth and Dominick-Lauter Medium with "Standard Lactose Broth."** E. B. EVANS and CLARENCE BAHLMAN. 35–8. Possibly due to fact that Ohio River dams have caused source of supply of Cincinnati to be somewhat impounded, percentage of *B. coli* test confirmations in chlorinated water has decreased from annual average of 80 per cent to as low as 29 per cent. Results of comparative tests with modified broth (see above) and standard lactose broth on gravity-settled water and on filtered water, and with DOMINICK-LAUTER medium and lactose broth on gravity-settled water are tabulated and discussed. In former series on settled water, percentage of modified broth tubes showing gas was 29.1, compared with 22.2 in case of lactose broth, percentages of confirmed tubes being 21.1 and 19.0, respectively, and percentages of presumptive positives confirmed, 71.4 and 85.7 respectively. With filtered water, corresponding percentages were 21.9 and 14.9, 20.6 and 13.6, and 92.0 and 91.4, respectively. Results obtained from undiluted portions examined were in better agreement than those from diluted samples. DOMINICK-LAUTER medium gave much fewer positive presumptive and confirmed tubes than did lactose broth. Of 75 portions each of 1, 0.1, and 0.01 cc. planted in each medium, 37, 6, and 1, respectively, showed gas in DOMINICK-LAUTER medium and 59, 20, and 1, respectively, in lactose broth: corresponding numbers of confirmed tubes being 36, 6, and 1, and 59, 19, and 1, respectively; i.e., practically 100 per cent confirmation in each case. Of 375 each ten-cc. portions of same samples planted in same two media, 371 and 375, respectively, showed gas. No confirmation figures are given for the 10-cc. plantings. Confirmations were made by streaking on eosin methylene blue agar and transplanting to lactose broth. **The Reservoir and the Pine Tree.** A. D. CLAGGETTE. 39–40. As remedy for weeds and washouts around banks, pine trees are being planted around Barberton reservoir. Pine trees not only crowd out all other vegetation within few years, leaving layer of pine needles which will not wash into reservoir, but also form network of roots, which prevents erosion and holds moisture, and add very materially to beauty of reservoir. Characteristics of species of pine and spruce adaptable to Ohio conditions are outlined. Cutting of such trees for Christmas use appears to be profitable field. If 2500 to 3000 trees per acre can be brought to marketable size and disposed of at only 30 cents each in wholesale lots over period of 10 years, gross income therefrom of $750 to $900 per acre would leave sufficiently attractive margin

over cost of production. In discussion, reforestation programs at several other cities as outlined. **Twenty-Five Years of Water Purification at Lorain.** THOMAS H. TRISTRAM. 41–4. Account of development of water purification at Lorain from 1897, when first plant, consisting of 6 circular wooden tank filters, was installed, two years after the Warren filters, the first of mechanical type built in Ohio. Lorain installation was first mechanical filter plant to be built under binding guarantee of efficiency. Removal of 97 per cent of bacteria growing on gelatin at 20°C. was guaranteed. Presence of *B. coli* was simply noted. The only provision for coagulation was a compartment below each filter, which in reality was simply a mixing chamber. Alum was employed as coagulant until 1901, when method known as "Jewell Iron Process," or "Iron Sulphite Process," was substituted, which consisted of burning brimstone in closed chamber, conducting sulphur dioxide formed through glass nozzle into condenser containing water, and passing the sulphurous acid solution through large wooden tank filled with scrap iron. Resulting solution, together with lime solution made from lump lime, was applied to raw water. This method was employed until 1903, when use of crystalline sulphate of iron and milk of lime was adopted as standard practice. Present plant consists of mixing chamber, coagulation basins, 10 rectangular concrete rapid sand filters, and clear well. **Disposal of Softening Plant Sludge at Marion, Ohio.** C. C. WHYSALL. 45. Field is being developed in vicinity of Marion for disposal of water softening sludge as substitute for agricultural lime. Material is supplied free. Neutralizing value of the sludge is 98 percent, as compared with agricultural lime available. In discussion (p. 15), author stated that sludge in the lagoons contains from 25 to 30 per cent moisture and is readily handled. C. P. HOOVER gave interesting data regarding the volume of sludge produced at Columbus. **The Use of Powdered Activated Carbon to Remove Tastes and Odors from Water.** CHARLES E. TROWBRIDGE. 46–7. Powdered activated carbon has been successfully employed for removal of tastes and odors at 10 plants of the American Waterworks and Electric Company. When applied to filter influents, dosage required has varied from 5 to 20 pounds per million gallons. Such amounts have not materially reduced the length of filter runs. At South Pittsburgh, where carbon was applied to raw water, as much as 135 pounds per million gallons was employed. The tastes and odors removed have been described as disagreeable, vegetable, musty, woody, and bitter. A distillation test has been developed for detecting slight traces of taste and odor producing substances. **Experiences in the Use of Activated Carbon at Sandusky.** O. F. SCHOEPFLE. 48–50. The Sandusky plant was remodeled during past year to provide for lime-soda softening. Plant arrangement provides utmost flexibility. As at present operated, water, derived from Sandusky Bay, passes through small preliminary settling basin and through mixing tank where alum, lime, and soda ash are added, into clarifier. After carbonation, water passes through second mixing tank and second clarifier to settling basins and thence to filters. Plant is operated to produce water with total hardness of 85 p.p.m.; throughout most of year this is accomplished without use of soda ash. Raw water has average total hardness of 150 p.p.m., and carbonate hardness of 100 p.p.m. By adding sufficient lime to produce causticity of 15 p.p.m. and carbonating to 5 p.p.m. of normal carbonate it

has been possible to reduce alkalinity to 37 p.p.m. Shortly after plant was placed in operation, and offensive odor, variously described as marshy, grassy, woody, moldy, musty, medicinal, and putrid, developed in the supply. Odor was not present in raw water, but became progressively stronger as water passed through plant and distribution system. Addition of 2 p.p.m.. of activated carbon (Aqua Nuchar) to water in second mixing basin effected marked improvement. Application of second dosage of 1 p.p.m. to applied water did not, however, result in appreciably increased removal. Application of 2 p.p.m. of carbon in second mixing chamber and returning sludge from second clarifier, containing most of the carbon, to first mixing chamber gave almost 100 percent removal. This method has been continued to present time, cost varying from 50 cents to $1.00 per million gallons. It is believed that odor was due to decomposition of organic matter, probably chiefly in form of algae. **Experiences in the Use of Activated Carbon at Warren.** PHILIP J. O'CONNOR. 50. Application of up to 3.6 p.p.m. of activated carbon (Nuchar) to filter influent at Warren failed to remove a slight grassy taste during a brief period of experimentation. Filter runs were not affected. Substitution of excess lime treatment for chlorination has hitherto been found the only effective remedy for medicinal tastes, but activated carbon has not as yet been tried for this purpose. **The Use of Activated Carbon, Defiance, Ohio.** FRANK S. TAYLOR. 51. Water supply of Defiance, derived from Maumee River, is softened by lime-soda method, recarbonated, and filtered. During dry seasons, water resembles impounded supply and at times a green scum extends almost entirely across river, a distance of 200 to 300 feet. Algae odors are always pronounced during cleaning of basins and musty and woody tastes and odors are present in plant effluent nearly every spring and fall. Prechlorination and ammonia-chlorine treatment have alike failed to remedy this condition. During summer of 1931, from 0.75 to 1.5 p.p.m. chlorine was applied to raw water, 5 to 8 pounds of activated carbon (Nuchar No. 2) per million gallons to settling basin effluent, and 0.5 p.p.m. chlorine in filter effluent; and, for first time in several years, supply was free of tastes and odors, notwithstanding that water in mixing and settling basins had strong disagreeable odor most of time. Very little, if any, reduction in filter runs was noted. Water on filters has a dark cast, immediately apparent to experienced operators, but not noticeable to other visitors. Cost of carbon is 7 cents per pound. In discussion (p. 19), W. I. VAN ARNUM reported that sludge in settling basins at Youngstown decomposes and imparts grassy taste to water: application of 15 to 16 pounds of activated carbon removes the taste; 6 pounds per million gallons was ineffective. At Portsmouth, application of 5 to 15 pounds of carbon per million gallons improved the taste of the water without increasing loss of head in filters. All who had used the method believed that the carbon was entirely removed by filters. Upper Sandusky employed activated carbon with marked success in contending with a very disagreeable taste during past summer; but at times it was necessary to apply as much as 50 pounds per million gallons. **Findlay's New Water Softening and Purification Plant.** E. I. ROBERTS. 52–5. The new lime-zeolite softening and filtration plant recently constructed at Findlay is described. Over 5-year period, hardness of supply, derived from springs and wells, averaged 405 p.p.m.; alkalinity, 263; non-

carbonate hardness, 142; and magnesium content, 37. Lime-zeolite was chosen as most economical method. Plant, which has capacity of 4 million gallons per day, with provision for extension to 8 million gallons, consists of raw water storage basin, 8 mechanical mixing tanks, 2 clarifiers, 1 carbonation chamber, 1 recarbonation chamber, 4 rapid sand filters, 3 zeolite filters, 2 clear wells, brine well, etc. One clear well is for lime-softened water, the other for zeolite-softened water; flow into mixing well being controlled by proportioning devices. Regeneration of zeolite is effected with 10 per cent brine. Quick lime employed for softening is handled by vacuum transport system. Alum may be applied at 5 different points in mixing tanks. Plant arrangement is most flexible, 4 different operating procedures being possible. Carbonation equipment consists of coke-fired boiler, flue-gas scrubber, and compressor. Emergency supply from Blanchard River was provided for. In **discussion** (p. 20), author stated that cost of plant was about $350,000. Carbonate hardness of untreated water is about 300 p.p.m.; incrustants about 200 p.p.m. Former is reduced to approximately 40 p.p.m. by lime treatment and sufficient of this water is passed through zeolite units to maintain final hardness of 100 p.p.m. Carbonation must be carried out with great care to avoid incrustation of zeolite. **Larval Contamination of a Clear Water Reservoir.** CLARENCE BAHLMAN. 56–8. Worms in water drawn from taps in Cincinnati were traced to open clear water reservoir at filter plant, which is 23 feet deep. The worm, identified by W. G. PURDY as larval stage of aquatic fly *Diptera chironomus*, is ½ to 1 inch in length and of bright red color, for which reason it is commonly called a blood-worm. About three-fourths of reservoir bottom was found to be covered with black sludge to depth of 10 or 12 inches. Sludge was not septic, but rapidly became so in laboratory. Under sludge, myriads of empty snail shells (*Planorbis*) were found, but no living specimens. As water receded from deposit during draining, many bright red, blood-colored areas, due to dense masses of writhing worms, appeared. Deposit, which, when dried, consisted of 58 percent ash and 42 percent volatile and combustible matter, is believed to have been due to wind-blown foliage, algae, and soot. Experiments at local U. S. P. H. S. stream pollution station have demonstrated that *Chironomidae* will deposit eggs on surface of clean tap water in a bucket and that blood-worm will develop in absence of visible sediment or food supply. Covering the reservoir seems to be only solution. Similar occurrence was experienced in Champaign, Illinois, in 1923 (cf. W. B. BUSHNELL, THIS J., 13: 653, June, 1925). Clear well of Champaign and Urbana Water Company at that time was covered with wooden roof which was not sealed to walls. Insect-proof concrete roof has since been constructed and no further trouble has been experienced. Textbooks state that the flies deposit their eggs on floating scum, or on clean surface of water. A generation is completed within about 5 weeks. The larva, or blood-worm, swims about with an active undulating motion, and develops in all types of water, fresh or stagnant, even in lake bottoms at great pressures. Worms develop from egg at bottom of body of water, and proceed to burrow through muck, fashioning tubular shelters for themselves from silt, or from other available material. Wall of tube is held together by silk-like secretion of salivary glands. Shelter-tubes are open at both ends, with net-like silken barrier at one opening. By vigorous

undulations, larva draws current of water into tube and feeds upon plankton organisms which become enmeshed in silken net. It may also reach out from tube and feed upon disintegrated plant tissues. Shelter-tubes and burrows will ramify into every available crevice. Final stage, the fly, is similar in size and appearance to common mosquito. A plate is given showing life cycle of the fly. In **discussion** (p. 21), L. H. ENSLOW stated that the insect developed annually for periods of about two weeks in settling basins at Panama water works. **Maintenance and Cleaning of Solution Feed Lines.** C. C. WHYSALL. 59–60. Use of separate feed lines for lime and soda solutions, increasing volume of water used, and substitution of trash pumps for ejectors for raising the solutions increased period between feed line cleanings at Marion from few days to two months in case of lime and to two weeks in case of soda ash. Subsequently, substitution of water from clarifier, containing 60 p.p.m. caustic alkalinity, for finished water for slaking practically stopped incrustation of lime solution lines. Coincidently, an increase in lime efficiency was observed. Fire hose, in which scale may be loosened by pounding with rubber mallet, has been found best for feed lines. Lime scale may be removed from portions of lines which are necessarily metallic by means of special boring tool. Scale in soda lines readily responds to several hours' flushing with steam or hot water. **Meter Rates, Meter Installations and Water Consumption.** 61–77. Detailed statistics are given for 266 Ohio municipalities, grouped according to population, type of supply, and nature of treatment employed. It is noted that average rates for water, when consumption is over 25,000 gallons per month, do not vary greatly regardless of size of municipality. Another conclusion is that, in general, lower rates may be expected in larger municipalities. Where metering is more complete, per capita consumption increases with population. Generally speaking, however, it is found that water consumption per capita is less in municipality having large percentage of metered services than in community of similar size having smaller percentage of metered services. Metering was reported as compulsory in 82.5 percent of municipalities replying to questionnaire. **Decennial Index.** 79–94. Author and subject indexes to first 10 reports, 1921 to 1930 inclusive, of Conference.—*R. E. Thompson.*

Proceedings of the Sixth Water Works Short Course, Publication No. 12, Engineering Experiment Station, Oklahoma A. & M. College, Stillwater, Oklahoma. May, 1930. 103 pages. TIGHTENING UP ON SOME LOOSE THINKING. W. A. DARDEN. 7–9. Plea for thorough test of yield-head conditions of a well before determining size and characteristics of pumping equipment. **Electric Water Pumping Costs Simplified.** WILLIAM PARKERSON. 9–12. Brief and clear statement of relations between discharge and head encountered in problem of fitting pumping equipment to conditions of desired performance. Paper is replete with formulas and graphs and should be of real value to operating man whose normal duties have not developed an intimate knowledge of mathematics of these relations. **Some Recent Water Works Installations.** R. F. RIDDLE. 13. Synchronous motors find favor in driving of large constant speed pumps for following reasons: they have better power factors and efficiency than induction motors at all speeds; at high speeds, induction motor

may cost slightly less; but as size increases, the margin becomes very slight; while as speed decreases, synchronous motor cost becomes less than that of induction motor; synchronous motors are as dependable as induction motors. **The Selection of Electrical Equipment for Pumping Plants.** H. H. BRADLEY 13–18. *Reciprocating, or Positive Displacement, Pumps* have starting torque values 125 to 250 per cent of normal full load torque. Horse-power required varies directly with pressure if speed is constant and directly with speed if pressure is constant. For constant speed service with D.C. supply, compound-wound motors are better than shunt motors. For constant speed service with A.C. supply, squirrel-cage motors thrown directly across the line may be used for small motors, of 5 h.p., or less. For larger pumps, wound rotor type of induction motor is preferable. For adjustable speed service with D.C. supply, compound-wound motors are used. For adjustable speed service with polyphase A.C. supply, slip-ring type motor with secondary resistance is generally employed. *Rotary Pumps* have starting torque values of 30 to 60 percent of normal full load torque. For constant speed service with D.C. supply, compound-wound motors are recommended. For constant speed service with A.C. supply, squirrel-cage auto-start, or slip-ring motors are used. *Centrifugal Pumps* have starting torque approximately 30 percent of normal full load torque. With discharge valve open at start, torque will increase rapidly to 100 percent. With discharge valve closed, torque at full speed will rarely exceed 60 percent of normal full load torque. For constant speed service, squirrel-cage motor is normally used up to 50 h.p., same may be used up to 500 h.p., but slip-ring motor may prove more satisfactory. Above 75 h.p., synchronous motor is favored where high power factor is desirable.

Weight of factors to be considered in purchase of motors

	percent
Reliability of manufacturer	25
Proximity and class of service available	5
Design	10
Completeness of details of proposition	2
Ease and accessibility of repair	5
Price	25
Shipment	5
Performance	10
Appearance	3
Materials and workmanship	10

[Very clear statement of application of motors to pumping service. Impossible to completely cover in brief abstract and should be consulted in original for full details.—ABSTR.]. **The Use of Diesel Engines in Water Works Service.** R. E. MCDONNELL. 18–31. Improvements in quality of water, well worth while, have proven expensive and have involved either increases in water rates, or reduction in operating costs. Diesel engines have done much in last 20 years to reduce cost. Manufacturers now offer entire installations and take pay from plant earnings under reduced rates. Examples are given of economies effected by installations of Diesel engines at Kearney, Missouri; Ponca City, Oklahoma; Sioux Falls, South Dakota; Duncan, Oklahoma; and

Purcell, Oklahoma. Diesel engines owe their advantage over other prime movements to greater thermal efficiency. Best steam plants in operation today have thermal efficiency not over 28 percent; average steam plants, 10 to 15 percent; Diesel engine plants, about 32 percent, without much variation from smallest to largest units. **Application of Hydrogen Ion Control to Water and Sewage Work.** H. M. TRIMBLE. 32–39. Meaning of pH is explained and methods for its determination are described. pH of water is an index of its complete preparation for precipitation. Optimum conditions for precipitation vary with season, temperature, and source of supply, requiring constant check of pH. Close control of pH effects much saving in coagulant. Brine solution for regeneration of zeolite beds can be controlled by observation of pH. Optimum conditions for solution of sewage sludge bear some relation to pH. **Mississippi Flood Prevention and Oklahoma's Part in It.** REN G. SAXTON. 39–44. History of disastrous floods in Mississippi Valley is recounted. Levee systems date from early French occupation (1717). First large flood within recent years was that of 1912. Several floods since that date have broken levees and caused enormous property damage (1916, 1922, and 1927). Greatest damage on record was produced by flood of 1927 when flood-flow of 2,000,000 c.f.s. inundated 20,000 of the 27,000 square miles protected by levees. Arkansas and Red River watersheds are of most importance in consideration of flood protection. Levee system is a first, but not impregnable, line of defence. Reservoir system is second line of defence and should be developed to much greater extent than at present. Considerable benefit can be secured by terracing of farms to increase percolation of rainfall. Bibliography. **Tulsa, Oklahoma, Water Supply.** W. F. ANDERSON. 44–46. History of development of Tulsa's water supply, culminating with Spavinaw project, under which contracts were awarded as follows:

Telephone line	$25,000.00
Clearing Spavinaw Site	22,500.00
Spavinaw Dam	840,365.00
60″ Conduit	2,200,858.00
Tunnel and Approaches	305,150.00
54″ Conduit	1,762,853.00
Mohawk Reservoir	155,070.00
Furnishing Cast-Iron Pipe	241,715.00
Furnishing Valves and Boxes	7,400.00
Laying Mains	51,604.00
High-Pressure Reservoir	150,592.00

Synopsis of Work of U. S. G. S. in Oklahoma. JOHN H. GARDINER. 46–52. There are now 30 stream-gaging stations in Oklahoma. Methods of stream-gaging are standard with U. S. G. S. Studies of ground water of Oklahoma have been carried out in several areas. Problem of ground water yield attacked from two aspects, first, that subsoil formations act as reservoirs, and second, as conduits. **Chickasha's Water Supply and Problems.** JESS LARSON. 53–55. Detailed description of present plant, built in 1924 and added to from time to time. Consideration now being given to use of Washita River at

Chickasha softened in lime-zeolite plant. **Well Construction at Walters.** ROBERT LINES. 56–58. Description of 16-inch gravel wall type well and pump installation. **Water Supply of Mangum.** H. L. LAWRENCE. 58–61. Problem of treating a water of 28- to 32-grain hardness was solved after consideration of lime-soda, sodium aluminate, combination lime-and-pressure zeolite, and gravity zeolite plants, by selection of last-named. Contracts for plant were awarded upon specifications which required bonded guarantee for salt consumption not in excess of 0.375 pound per 1,000 grains of hardness removed; and guaranteed replacement cost of zeolite lost. Water is pumped three times; from well to 250,000-gallon raw water reservoir; thence through softener into 260,000-gallon soft water reservoir; and thence into city mains. There are two ½-million-gallon per day gravity zeolite softening units. They require four regenerations per 24 hours. Water from softeners has zero hardness and is mixed with raw water to bring the resulting hardness to from 3 to 5 grains per gallon. Chemical cost of softening plant is less than 5 cents per thousand gallons. **A Discussion of Zeolite Water Softeners.** ROBERT P. MOSCRIP. 61–75. History of zeolites from first discovery of natural materials through development of synthetic zeolites is given. Reaction of zeolites with dissolved hardening minerals in water and regeneration process are described. Three general types of zeolites are now available. (1) *Natural greensand* softens and regenerates at very rapid rate which allows high rates of flow and reduces time required for regeneration. It is a hard and dense material, with low attrition loss, and inexpensive. On the other hand, its exchange capacity is low, necessitating large units. It contains considerable iron, which is, in some cases, imparted to the softened water. Its composition varies. It is heavy, which imposes some difficulty in washing of upflow units. (2) *Natural clay* possesses long life and lower attrition loss. It has higher capacity than greensand and, being lighter, washes more easily in upflow units. On the other hand, its reaction and regeneration times are slow. It is sensitive to iron and cannot well be used with waters carrying much iron. Being a natural product, its composition is not uniform. (3) *Synthetic* zeolites contain only the active ingredients, in uniform composition. They have high capacity, due to porosity. On the other hand, being soft, they have high attrition loss. They are slower in softening and regenerating reactions. Zeolite softeners are usually designed either as down-flow or as up-flow units. Proponents of down-flow units claim better distribution and therefore greater capacity. The down-flow softener acts to a large extent as a filter and removes some suspended matter. On the other hand, the down-flow method tends to pack the grains of zeolite more closely, resulting in lower capacity and higher friction loss. Necessity for increased backwashing pressures may result in loss of zeolite. Up-flow softener does not require backwashing and thus saves time and water during regeneration. The mineral bed is in semi-suspension during normal operation and low friction loss results. On the other hand, unless careful attention is given to the design of distributing piping, distribution of flow through the bed may not be as good as in down-flow softening. Care must also be taken to protect against carrying zeolite out of the unit. Many variations in design of elements in softeners have been introduced. Under certain conditions, zeolite plants are to be preferred to

lime-soda softening plants. In some cases, where water to be treated has a high temporary hardness and where sedimentation and filtration are necessary for other reasons, combination lime and zeolite softening plants may prove advantageous. **The Measurement and Control of the Flow of Water.** E. E. MOREY. 75–78. Description of manner of application of Venturi tube to measurement of flowing water. **Sanitation in the Dressing Room.** Dr. G. F. MATHEWS. 78–80. The swimming pool is a good example of an institution which, devised to improve hygienic conditions, may yet itself be a hygienic menace. Utmost care should be exercised in planning of swimming pool facilities and in their use and maintenance. **Financing of Swimming Pool.** W. H. MCPHEETERS. 80–84. Public pools may be financed out of public funds, by public subscriptions, by membership fees, by capitalization of admission fees. Experiences of many cities are quoted to indicate various methods. **Operation of the Tulsa Filtration Plant.** A. B. JEWELL. 84–87. Tulsa secures water supply either directly from Spavinaw conduit, or from diversion through Mohawk Lake. Raw water is first treated with lime, then aërated by diffusing air through filtros plates in bottom of flume; after which, alum is added. Water is then led to two circular mixing basins, operated in parallel, to give mixing period of approximately one-half hour. Two settling basins, giving detention period of approximately 4 hours, are provided. There are six 4-m.g.d. filters. Water is treated only for turbidity removal, no attempt being made to soften. Operation cost per million gallons for March 1930 was $6.47; including salary and labor, $3.24; chemicals, $2.01; power and light, $1.22. **Selling the Sewage Treatment Plant to the Public.** V. V. LONG. 90. Discussion of the difficulties of convincing municipalities of necessity of sewage treatment. **Lawton's Activated Sludge Plant.** A. D. BULL and ABE MULL. 90–94. **Functions of the State Board of Health of Missouri with Respect to Public Water Supplies.** W. SCOTT JOHNSON. 95–101. Duties of State Board of Health as prescribed by law are quoted. Under these authorizations an engineer of State Board of Health visits each public water supply in State and makes complete survey of all physical conditions. Desirable changes in plant and equipment are discussed with local officials and summarized in report. Each year annual report of all public water supplies is furnished. State Board of Health has organized and sponsored Missouri Water and Sewage Conference, at meetings of which papers and discussions on many phases of water treatment and purification are given. Short course in biology, bacteriology, and chemistry of water purification is given as corollary to conference.—*R. L. McNamee.*

Proceedings Seventh Water Works Short Course Held at Oklahoma A. & M. College April, 1931. Publication No. 14, Engineering Experiment Station, Stillwater, Okla., 1932, pp. 3–52. **Use of Chloramine in Tulsa Water Supply.** A. B. JEWELL. 3–6; also Southwest Water Works Journal, 13: 4, 15–16, 1931. Apparently algae, predominantly diatoms, but especially *Spirogyra* and *Fragillaria* caused tastes and odors in Tulsa supply. Chloramine did not prevent, or remove, these tastes; but even a very small amount of chlorine in combination with ammonia was sufficient to cause objectionable tastes. Under chloramine treatment, bacterial counts were found to increase with

increase of pH: cf. HOLWERDA, C. A., 23: 1704. (*Courtesy Chem. Abst.*) **Results Obtained by the Use of Ammonia (Chloramine) in the Lawton, Oklahoma, Filtration Plant.** A. D. BULL and ALLEN METCALF. 7–18; also Southwest Water Works J., 13: 6, 15–20, 1931. Use of chloramine has increased filter runs, reduced wash water consumption, destroyed aftergrowths, and permitted higher residual chlorine without complaints. (*Courtesy Chem. Abst.*) **Use of Ammonia in the Perry Water and Sewage Plants at Perry.** PERCY S. DANIELS. 18–20. **The Influence of Conditions and of Other Substances Upon Determination of Chlorine by the Ortho-Tolidin Method.** OTTO M. SMITH. 21–22. Summary of various factors and of their respective effects upon accuracy of *ortho*-tolidin test for chlorine. **The Need of Algae Control in Water Supplies.** F. R. HASSLER. 22–25. Reports of cases where algae were cause of odors, tastes, or clogged filters. Coco-cola could not be made with one water so contaminated. **New and Old Water Supplies at Clinton, Oklahoma.** J. E. MAUK. 25–27. Description of supply and plant of Clinton, Oklahoma. **Public Relations of Water Companies.** C. E. PERKINS. 27–29. The superintendent should endeavor to produce the best water possible, to be fair and accommodating, to render prompt service and to sell the company and its products to the citizens. **Improving Public Relations.** R. C. DOHE. 29–34; also Water Works Engineering. Public relations are the important intangible connections between water company, or department, and customers; they are improved by systematic plan of creating favorable public impression; many examples of how this may be done are given. **The Disposal of Oil Field Brines.** LUDWIG SCHMIDT. 34–35. One single well may produce several hundred barrels of brine per day. The four general methods of disposal are: (1) evaporating and impounding ponds; (2) salt recovery plants; (3) diversion into selected streams; and (4), feasible only in isolated instances, return to sub-surface formations. **Importance of Records in Water Systems.** MORRIS B. CUNNINGHAM. 35–38. Explanation of methods used in Oklahoma City, Oklahoma. **Chlorinated Sulfate of Iron as a Coagulant.** C. ARTHUR BROWN. 38–42; also Southwest Water Works J., 13: 5, 19–21, 1931. A general discussion. (*Courtesy Chem. Abst.*) **Water Hammer: Its Cause and Effect.** R. L. FLANDERS. 42–46. Discussion of cause; of nature of pressure wave; of maximum possible water hammer; of effect of velocity with which valve is closed; and of results yielded by more common formulas for water hammer. **Aer-O-Mix—An Effective Aërator and Intimate Mixer.** H. B. ANDERSON. 47–49; also as **Combined Aëration and Mixing in Water Treatment** in Southwest Water Works Journal, 13: 2, 15, 1931. Good mixing in water treatment means quicker settling, longer filter runs, less chemicals, and 20 to 50 percent less wash water. Aëration with mixing may be used either to remove carbon dioxide, or to recarbonate with greater efficiency. (*Courtesy Chem. Abst.*) **Water and Sewerage Systems of Ada, Oklahoma.** HENRY KROTH. 47–52. Description of water system of Ada, Oklahoma.—*O. M. Smith.*

GEORGE W. PRACY, PRESIDENT, 1932–1933